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[1] Withdrawn for publication elsewhere.

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(Organized 1889, Incorporated December 29, 1913)

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P. J. Parrott, Geneva, New York.

Councillors for the American Association for the Advancement of Science.

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T. J. Headlee, New Brunswick, New Jersey.

LIST OF MEETINGS AND PAST OFFICERS

First Annual Meeting, Washington, D. C., Nov. 12–14, 1889. President, C. V. Riley; First Vice-President, S. A. Forbes; Second Vice-President, A. J. Cook; Secretary, John B. Smith.

Second Annual Meeting, Champaign, Ill., Nov. 11–13, 1890. (The same officers had charge of this meeting.)

Third Annual Meeting, Washington, D. C., Aug. 17–18, 1891. President, James Fletcher; First Vice-President, F. H. Snow; Second Vice-President, Herbert Osborn; Secretary, L. O. Howard.

Fourth Annual Meeting, Rochester, N. Y., Aug. 15–16, 1892. President, J. A. Lintner; First Vice-President, S. A. Forbes; Second Vice-President, J. H. Comstock; Secretary, F. M. Webster.

Fifth Annual Meeting, Madison, Wis., Aug. 14–16, 1893. President, S. A. Forbes; First Vice-President, C. J. S. Bethune; Second Vice-President, John B. Smith; Secretary, H. Garman.

Sixth Annual Meeting, Brooklyn, N. Y., Aug. 14–15, 1894. President, L. O. Howard; First Vice-President, John B. Smith; Second Vice-President, F. L. Harvey; Secretary, C. P. Gillette.

Seventh Annual Meeting, Springfield, Mass., Aug. 27–28, 1895. President, John B. Smith; First Vice-President, C. H. Fernald; Secretary, C. L. Marlatt.

Eighth Annual Meeting, Buffalo, N. Y., Aug. 21–22, 1896. President, C. H. Fernald; First Vice-President, F. M. Webster; Second Vice-President, Herbert Osborn; Secretary, C. L. Marlatt.

Ninth Annual Meeting, Detroit, Mich., Aug. 12–13, 1897. President, F. M. Webster; First Vice-President, Herbert Osborn; Second Vice-President, Lawrence Bruner; Secretary, C. L. Marlatt.

Tenth Annual Meeting, Boston, Mass., Aug. 19–20, 1898. President, Herbert Osborn; First Vice-President, Lawrence Bruner; Second Vice-President, C. P. Gillette; Secretary, C. L. Marlatt.

Eleventh Annual Meeting, Columbus, Ohio, Aug. 18–19, 1899. President, C. L. Marlatt; First Vice-President, Lawrence Bruner; Second Vice-President, C. P. Gillette; Secretary, A. H. Kirkland.

Twelfth Annual Meeting, New York, N. Y., June 22–23, 1900. President, Lawrence Bruner; First Vice-President, C. P. Gillette; Second Vice-President, E. H. Forbush; Secretary, A. H. Kirkland.

Thirteenth Annual Meeting, Denver, Colo., Aug. 23–24, 1901. President, C. P. Gillette; First Vice-President, A. D. Hopkins; Second Vice-President, E. P. Felt; Secretary, A. L. Quaintance.

Fourteenth Annual Meeting, Pittsburgh, Pa., June 27–28, 1902. President, A. D. Hopkins; First Vice-President, E. P. Felt; Second Vice-President, T. D. A. Cockerell; Secretary, A. L. Quaintance.

Fifteenth Annual Meeting, Washington, D. C., Dec. 26–27, 1902. President, E. P. Felt; First Vice-President, W. H. Ashmead; Second Vice-President, Lawrence Bruner; Secretary, A. L. Quaintance.

Sixteenth Annual Meeting, St. Louis, Mo., Dec. 29–31, 1903. President, M. V. Slingerland; First Vice-President, C. M. Weed; Second Vice-President, Henry Skinner; Secretary, A. F. Burgess.

Seventeenth Annual Meeting, Philadelphia, Pa., Dec. 29–30, 1904. President, A. L. Quaintance; First Vice-President, A. F. Burgess; Second Vice-President, Mary E. Murtfeldt; Secretary, H. E. Summers.

Eighteenth Annual Meeting, New Orleans, La., Jan. 1–4, 1906. President, H. Garman; First Vice-President, E. D. Sanderson; Second Vice-President, F. L. Washburn; Secretary, H. E. Summers.

Nineteenth Annual Meeting, New York, N. Y., Dec. 28–29, 1906. President, A. H. Kirkland; First Vice-President, W. E. Britton; Second Vice-President, H. A. Morgan; Secretary, A. F. Burgess.

Twentieth Annual Meeting, Chicago, Ill., Dec. 27–28, 1907. President, H. A. Morgan; First Vice-President, H. E. Summers; Second Vice-President, W. D. Hunter; Secretary, A. F. Burgess.

Twenty-first Annual Meeting, Baltimore, Md., Dec. 28–29, 1908. President, S. A. Forbes; First Vice-President, W. E. Britton; Second Vice-President, E. D. Ball; Secretary, A. F. Burgess.

Twenty-second Annual Meeting, Boston, Mass., Dec. 28–29, 1909. President, W. E. Britton; First Vice-President, E. D. Ball; Second Vice-President, H. E. Summers; Secretary, A. F. Burgess.

Twenty-third Annual Meeting, Minneapolis, Minn., Dec. 28–29, 1910. President, E. D. Sanderson; First Vice-President, H. T. Fernald; Second Vice-President, P. J. Parrott; Secretary, A. F. Burgess.

Twenty-fourth Annual Meeting, Washington, D. C., Dec. 27–29, 1911. President, F. L. Washburn; First Vice-President, E. D. Ball; Second Vice-President, R. H. Pettit; Secretary, A. F. Burgess.

Twenty-fifth Annual Meeting, Cleveland, Ohio, Jan. 1–3, 1913. President, W. D. Hunter; First Vice-President, T. J. Headlee; Second Vice-President, R. A. Cooley; Secretary, A. F. Burgess.

Twenty-sixth Annual Meeting, Atlanta, Ga., Dec. 31, 1913–Jan. 2, 1914. President, P. J. Parrott; First Vice-President, E. L. Worsham; Second Vice-President, Wilmon Newell; Secretary, A. F. Burgess.

Twenty-seventh Annual Meeting, Philadelphia, Pa., Dec. 28–31, 1914. President, H. T. Fernald; First Vice-President, Glenn W. Herrick; Second Vice-President, W. E. Britton; Third Vice-President, Wilmon Newell; Secretary, A. F. Burgess.

Special Meeting, Berkeley, Cal., Aug. 9–10, 1915. (Officers same as for Twenty-eighth Annual Meeting.)

Twenty-eighth Annual Meeting Columbus, Ohio, Dec. 27–30, 1915. President,

Glenn W. Herrick; First Vice-President, R. A. Cooley; Second Vice-President, W. E. Rumsey; Third Vice-President, E. F. Phillips; Secretary, A. F. Burgess.

Twenty-ninth Annual Meeting, New York, N. Y., Dec. 28–30, 1916. President, C. Gordon Hewitt; First Vice-President, G. A. Dean; Second Vice-President, E. D. Ball; Third Vice-President, W. J. Schoene; Fourth Vice-President, T. J. Headlee; Secretary, A. F. Burgess.

Thirtieth Annual Meeting, Pittsburgh, Pa., Dec. 31, 1917–Jan. 2, 1918. President, R. A. Cooley; First Vice-President, W. E. Hinds; Second Vice-President, A. W. Morrill; Third Vice-President, G. M. Bentley; Fourth Vice-President, B. N. Gates; Secretary, A. F. Burgess.

Thirty-first Annual Meeting, Baltimore, Md., Dec. 26–27, 1918. President, E. D. Ball; First Vice-President, W. C. O'Kane; Second Vice-President, G. P. Weldon; Third Vice-President, E. C. Cotton; Fourth Vice-President, Franklin Sherman, Jr.; Secretary, A. F. Burgess.

Thirty-second Annual Meeting, St. Louis, Mo., Dec. 31, 1919–Jan. 2, 1920. President, W. C. O'Kane; First Vice-President, A. G. Ruggles; Second Vice-President, H. J. Quayle; Third Vice-President, E. C. Cotton; Fourth Vice-President, W. E. Britton; Secretary, A. F. Burgess.

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Mally, C. W., Department of Agriculture, Cape Town, South Africa.
Marchal, Dr. Paul, 16 Rue Claude-Bernard, Paris, France.
Mokshetsky, Sigismond, Musée 'd'Histoire Naturelle, Simferopole, Crimea, Russia.
Mussem, Charles T., Hawkesbury Agricultural College, Richmond, New South Wales.
Nawa, Yashushi, Entomological Laboratory, Kyomachi, Gifu, Japan.
Newstead, Robert, University School of Tropical Medicine, Liverpool, England.
Porter, Carlos E., Casilla 2352, Santiago, Chili.
Pospielow, Dr. Walremar, Station Entomologique, Rue de Boulevard, No. 9, Kiev, Russia.
Reed, Charles S., Mendoza, Argentine Republic, South America
Ritzema, Bos, Dr. J., Agricultural College, Wageningen, Netherlands.
Rosenfeld, A. H., Ingenio Santa Ana, F. C. N. O. A., Tucuman, Argentina.
Sajo, Prof. Karl, Gödöllö-Veresegyház, Hungary.
Schoyen, Prof. W. M., Zoölogical Museum, Christiania, Norway.
Severin, Prof. G., Curator Natural History Museum, Brussels, Belgium.
Shipley, Prof. Arthur E., Christ's College, Cambridge, England.
Silvestri, Dr. F., R. Scuola Superiore di Agricoltura, Portici, Italy.
Theobald, Frederick V., Wye Court, Wye, Kent, England.
Thompson, Rev. Edward H., Franklin, Tasmania.
Tryon, H., Queensland Museum, Brisbane, Queensland, Australia.
Urich, F. W., Victoria Institute, Port of Spain, Trinidad, West Indies.
Vermorel, V., Station Viticole, Villefranche, Rhone, France.

THIRTY-THIRD ANNUAL MEETING OF THE AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

Chicago, Ill., December 29–31, 1920

The thirty-third annual meeting of the American Association of Economic Entomologists will be held in Kent 20, University of Chicago, December 29 to 31, inclusive.

Sessions will open at 10 a. m., Wednesday, December 29. The annual reports of officers and standing committees will be presented and the opening business transacted. This will be followed by the annual address of the President. The meeting will be continued at 1.30 p. m., and on Thursday morning at 10 a. m. Papers will be presented at the Friday afternoon session and the final business will be transacted at that time.

Sectional Meetings

The meeting of the Section on Apiculture will be held at 8.00 p. m., Wednesday, December 29. The Section on Horticultural Inspection will meet at 1.30 p. m., Thursday, December 30.

Joint Meeting

A joint meeting of this association with the American Phytopathological Society will be held in Mandel Hall, University of Chicago, Friday, at 10 a. m.

Other Meetings

The annual meeting of the American Association for the Advancement of Science and its many affiliated societies will be held throughout the week. The Entomological Society of America will meet on Monday and Tuesday, December 27 and 28.

Hotel Headquarters

Headquarters for this association will be at the Sherman Hotel, Clark and Randolph streets, where the following rates have been secured:

	Without Bath	With Bath
One in room	$2 50–$3 00	$3 50–$6.00
Two in room	4.00–	5.00–10.00

Members must engage rooms promptly, as the hotel is likely to be crowded.

Railroad Rates

Information concerning railroad rates to the meeting should be secured direct from Dr. Burton E. Livingston, Permanent Secretary, American Association for the Advancement of Science, Smithsonian Institution, Washington, D. C.

Smoker

The members of this association are invited to attend the Biologists' Smoker which will be held Tuesday evening, December 28, at 8.00 p. m. Dr. W. M. Wheeler will give the Vice-Presidential Address of Section F at the opening of the smoker, on "The Organization of Research." The place for holding this smoker will be announced later.

Dinner

The President of the association has planned for an entomologists' dinner similar to the one held at the last annual meeting, and Thursday evening, December 30, has been reserved for this event. Arrangements for the dinner are being made by a committee of which Mr. W. C. O'Kane is Chairman. Further details will be announced at the time of the meeting.

Membership

Applications for membership can be secured from the Secretary or from members of the committee on membership. All applications should be made out, properly endorsed, and filed with the membership committee on or before December 30.

Program

Wednesday, December 29, 1920, 10.00 a. m.

Report of the Secretary.

Report of the executive committee, by President Wilmon Newell.

Report of the representative to the National Research Council, by P. J. Parrott, Geneva, N. Y.

Report of the committee on policy, by W. C. O'Kane, Durham, N. H.

Report of the committee on nomenclature, by Edith M. Patch, Orono, Me.

Report of the committee on index of economic entomology, by E. P. Felt, Albany, N. Y.

Appointment of committees.

Miscellaneous business.

New business.

Annual address of the President, Wilmon Newell, Gainesville, Fla., "On the Organization of Work in Economic Entomology."

Addr ss by Dr. C. E. McClung, Chairman, Division of Biology and Agriculture, National Research Council.

"Industrial Support for Scientific Work," by W. C. O'Kane, Durham, N. H. (15 minutes.)

Adjournment.

Program

Wednesday, December 29, 1920, 1.30 p. m.

Discussion of the Presidential Address.

Reading of Papers

"A Volunteer Pest Reporting Service," by S. B. Fracker, Madison, Wis. (10 minutes.)

The corps of volunteer pest correspondents secures valuable information for immediate use and for permanent records.

"The Value of Entomological Service to the Ohio Farm Bureaus in Their Effort to Control the Hessian-fly," by H. A. Gossard, Wooster, Ohio, and T. H. Parks, Columbus, Ohio. (15 minutes.) Lantern.

How research and extension methods were used to guide the growers past a late departing fall brood of fly.

"Facts Concerning Periodical Outbreaks of Beet Leaf-hopper (*Eutettix tenella* Baker) in California," by Henry H. P. Severin, Berkeley, Calif. (15 minutes.)

Migrations depleting the natural breeding area is the primary factor and parasitism is of secondary importance in causing the periodicity of the beet leaf-hopper (*Eutettix tenella* Baker).

"The Potato Leaf-hopper and Tarnished Plant Bug in 1916," by S. Marcovitch, Knoxville, Tenn. (5 minutes.)

"Further Notes on the Life History of the Potato Leaf-hopper," by Albert Hartzell, Ames, Iowa. (10 minutes.)

Additional data on life history of *E. mali* with special reference to maximum number of eggs per female, longevity of adults and number of generations.

"The Influence of Leaf-hopper Control on Potato Yields," by John R. Eyer, State College, Pa. (5 minutes.)

A brief discussion of results obtained in commercial potato plantings.

"Further Experiments with *Empoasca mali* Concerning Its Relation to Potato Tipburn," by F. A. Fenton, Ames, Iowa. (10 minutes.)

Progress report of the season's work on the production of tipburn.

"Chinch-bug Resistance Shown by Certain Varieties of Corn," by W. P. Flint, Urbana, Ill. (10 minutes.) Lantern.

Results of three years' work with certain drought resistant varieties of corn to test their resistance to chinch-bug.

"Life History of the Native Corn Borer (*Pyrausta ainsliei* Heinr.) at Ames, Iowa," by I. L. Ressler, Ames, Iowa. (10 minutes.)

Report on biology and seasonal history of this pest.

"Some Results of Variety Tests in the European Corn Borer Investigation in Central New York," by C. F. Turner, Schenectady, N. Y. (10 minutes.)

Showing the relative susceptibility of different types of corn to corn borer injury.

"European Corn Borer in New York State," by E. P. Felt, Albany, N. Y. (15 minutes.)

A summary of recent investigations with special reference to control methods.

"The Corn Leaf Aphis (*Aphis maidis* Fitch) in Kansas," by James W. McColloch, Manhattan, Kan. (10 minutes.) Lantern.

Importance, life history and certain control measures.

"The Effect of Poisoned Bran Mash on Grasshoppers and the Lapse of Time Between Poisoning and Death," by A. L. Ford, Brookings, S. D. (To be read by title.)

"Observations on the Attractiveness of Materials Used in Grasshopper Baits," by A. L. Ford, Brookings, S. D., and W. H. Larrimer, W. Lafayette, Ind. (To be read by title.)

"Some Factors Influencing the Efficiency of Grasshopper Baits," by W. H. Larrimer, W. Lafayette, Ind., and A. L. Ford, Brookings, S. D. (To be read by title.)

"Arizona Wild Cotton and Its Insect Enemies in Relation to the Cotton Industry of the Arid Southwest," by A. W. Morrill, Los Angeles, Calif. (15 minutes.)

A consideration of a complicated entomological problem and methods by which it may be handled without unnecessarily endangering cultivated cotton.

"A Contribution Toward the Control of *Peridroma saucia* as a Tomato Fruit Worm," by C. L. Metcalf, Columbus, Ohio. (3 minutes.) Lantern.

Successful use of a poisoned bait against this pest on maturing tomatoes.

"The Pea Moth in Wisconsin," by Chas. L. Fluke, Jr., Madison, Wis. (6 minutes.)

A review of the life history and habits of the moth and a short discussion of control measures.

"Observations of the Fall Army Worm and Some Control Experiments," by Roger C. Smith, Manhattan, Kan. (8 minutes.)

Field observations on our recent outbreak and control experiments with poison bran mash prepared several ways.

"*Mecas inornata* Say, a Girdler on Artichoke," by W. J. Baerg, Fayetteville, Ark. (5 minutes.) Lantern.

A brief description of the insect and the injury caused by it.

Adjournment.

SECTION OF APICULTURE

F. B. Paddock, *Chairman.* G. M. Bentley, *Secretary.*

Program

Wednesday, December 29, 1920, 8.00 p. m.

Address by the Chairman—"Better Queens"—F. B. Paddock, Ames, Iowa.

Reading of Papers and Discussions

"Some Apicultural Investigations," by Wallace Park, Ames, Iowa. (15 minutes.)

"The Problem of Controlled Fertilization of Queen Bees," by L. V. France, University Farm, St. Paul, Minn. (10 minutes.)

"The Relationship Between the Complete Life Cycle of the Honey Bee and the Blooming Dates of the More Important Honey Plants," by H. B. Parks, San Antonio, Texas. (10 minutes.)

"Further Notes on the Value of Winter Production of Bees," by J. H. Merrill, Manhattan, Kan. (15 minutes.)

"Beekeeping Problems Which Should Be Undertaken by the Experiment Stations," by Frank C. Pellett, Hamilton, Ill. (10 minutes.)

Symposium—Foul Brood—(40 minutes).

"Stopping the Distribution of American Foul Brood at Its Source," by S. B. Fracker, Madison, Wis.

"Legislation for Control of Foul Brood," by M. C. Tanquary, College Station, Texas.

"Mixed Infections in the Brood Diseases of Bees," by A. P. Sturtevant, Washington, D. C.

"The Future of Bee Disease Control," by E. F. Phillips, Washington, D. C.

Transaction of business and selection of officers.

Adjournment.

Program

Thursday, December 30, 1920, 10.00 a. m.

Reading of Papers

"Control Work on the Pecan Nut Case Bearer," by S. W. Bilsing, College Station, Texas. (15 minutes.)

This paper summarizes the control work on the pecan nut case bearer. A comparison is made of twenty-five sprayed trees with twenty-five unsprayed trees for the season of 1920.

"Lepidopterous Larvæ Injurious to Apple in Pennsylvania," by S. W. Frost, Arendtsville, Pa. (10 minutes.)

Including several new injurious species.

"Fumigation with Hydrogen Cyanide for the Control of the Pear Psylla," by R. L. Webster, Ithaca, N. Y. (10 minutes.) Lantern.

A brief account of experiments in which an attempt is made to apply California fumigation methods to New York State.

"Studies of the Western Peach and Prune Root Borer (*Sanninoidea opalescens*)," by Frank H. Lathrop and A. B. Black, Corvallis, Ore. (5 minutes.) Lantern.

Observations on life history and habits of the root borer in Oregon with brief discussion of control methods tested by the Oregon Experiment Station.

"Some Experiments with Paradichlorobenzene and Other Chemicals for the Control of the Peach Tree Borer, *Sanninoidea exitiosa* Say," by Alvah Peterson, New Brunswick, N. J. (15 minutes.) Lantern.

The effect of paradichlorobenzene, orthodichlorobenzene, mercuric chloride, etc., on peach trees and peach tree borers of varying ages.

"Parasitism and Nicotine in the Control of the Oriental Peach Moth: A Second Report," by Louis A. Stearns, Leesburg, Va. (10 minutes.)

"The Codling Moth,—a Quandary and a Query," by Glenn W. Herrick, Ithaca, N. Y. (5 minutes.)

A general summary of the problem of control for purposes of discussion.

"The Status of the Work Against the Green Japanese Beetle," by C. H. Hadley, Riverton, N. J. (12 minutes.)

Present status of the project; future plans.

"Some Insect Problems Confronting the Avocado Grower," by G. F. Moznette, Miami, Fla. (10 minutes.)

A short paper describing what insects are of especial importance to the avocado industry in the United States, injury caused, etc.

"The Spreading of Sprays," by William Moore, St. Paul, Minn (15 minutes.)

Discussion of theory of spreading of sprays and the substances which will produce spreading.

"Notes on a New Insecticide," by E. N. Cory, College Park, Md. (8 minutes.)

An alcoholic extract of pyrethrum which shows considerable promise from tests on a number of different insects.

"Biological Control Work Against the Black Scale in California," by Harry S. Smith, Sacramento, Calif.

Adjournment.

SECTION OF HORTICULTURAL INSPECTION

J. G. SANDERS, *Chairman.* E. R. SASSCER, *Secretary.*

Program

Thursday, December 30, 1920, 1.30 p. m.

Address by the Chairman, J. G. Sanders, Harrisburg, Pa.

READING OF PAPERS AND DISCUSSIONS

"Recent Work of the Federal Horticultural Board," by C. L. Marlatt, Washington, D. C. (15 minutes.)

"Present Status of the Gipsy Moth in New Jersey," by Thomas J. Headlee, New Brunswick, N. J. (15 minutes.)

"Activities of the Federal Horticultural Board on the Mexican Border," by O. D. Deputy, Laredo, Texas. (15 minutes.)

"Standardized Nursery Inspection," by F. M. O'Byrne, Gainesville, Fla. (15 minutes.)

"Some Problems in Greenhouse Inspection in Indiana," by H. F. Dietz, Indianapolis, Ind. (15 minutes.)

"Sweet Potato Weevil Eradication in Florida," by J. E. Graf, Macclenny, Fla. (15 minutes.)

"Plant Quarantine Work at Florida Ports," by J. H. Montgomery, Gainesville, Fla. (15 minutes.)

"Operation of Quarantine 37," by R. Kent Beattie, Washington, D. C. (15 minutes.)

"The Japanese Beetle Quarantine," by C. W. Stockwell, Riverton, N. J. (5 minutes.)

"Important Foreign Insect Pests Collected on Imported Nursery Stock in 1920," by E. R. Sasscer, Washington, D. C. (15 minutes.)

Transaction of business and selection of officers.

Adjournment.

Program

Friday, December 31, 1920, 10.00 a. m.

Joint meeting of the American Association of Economic Entomologists and the American Phytopathological Society. Dr. W. A. Orton, President of the American Phytopathological Society, will preside.

Symposium on "Dusting as a Means of Controlling Injurious Insects and Plant Diseases." Insect control will be presented by P. J. Parrott, Geneva, N. Y., and T. J. Headlee, New Brunswick, N. J. Plant disease control by N. J. Giddings, Morgantown, W. Va., and H. A. Edson, Washington, D. C. Each paper will be presented in 10 minutes, after which the whole subject will be thrown open for general discussion.

Adjournment.

Program

Friday, December 31, 1920, 1.30 p. m.

Reading of Papers and Discussions

"Ecological Observations on the Hemiptera of the Cranberry Lake Region of the Adirondacks," by Herbert Osborn, Columbus, Ohio, and C. J. Drake, Syracuse, N. Y. (10 minutes.) Lantern.

General survey of ecologic conditions with observations on economic relations and mention of some of the more important species.

"Insects Attacking Ferns in the Hawaiian Islands," by O. H. Swezey, Honolulu, Hawaii. (5 minutes.)

Enumeration and notes on the same.

"Recent Insect Immigrants in Hawaii," by O. H. Swezey, Honolulu, Hawaii. (10 minutes.)

List with notes of first records and spread.

"An Insect Fearing Neither Fire nor Water," by A. C. Burrill, Columbia, Mo. (15 minutes.) Lantern.

The government 1918 campaign was first to gain success over the coulee cricket (*Peranabrus scabricollis*) and the ways devised to control them are applicable to other Orthoptera.

"Grasshopper and Cricket Repellents," by W. H. Larrimer, W. Lafayette, Ind. (5 minutes.) Lantern.

Results of experiments to secure a material with which binder twine can be treated to prevent the cutting of bands by insects while grain is in the shock.

"The Response of the Bean Weevil to Different Percentages of Atmospheric Moisture," by Thomas J. Headlee, New Brunswick, N. J. (15 minutes.) Lantern.

Response indicated by a curve; the response has been determined under a constant temperature of 80° F.

"Flour Mill Fumigation with Liquid Hydrocyanic Acid," by E. A. Back, Washington, D. C. (5 minutes.)

General statement regarding use.

"The European Red Mite, *Paratetranychus pilosus* Can. and Fanz., in Connecticut," by Philip Garman, New Haven, Conn. (5 minutes.)

"Preliminary Notes on Control of Millipedes Under Sash," by J. L. Horsfall and J. R. Eyer, State College, Pa. (10 minutes.)

Comparative data on use of insecticides and repellents for control of millipedes.

"Life History of *Peridroma margaritosa*," by F. M. Wadley, Rockford, Ill. (10 minutes.)

Brief paper giving records of occurrence and rearing in their bearing on the life and seasonal history of the species. Note on dimorphism.

"Notes on the Life History and Control Methods of the Box Wood Leaf-miner (*Monarthropalpus buxi* Labon.)," by C. C. Hamilton, College Park, Md. (10 minutes.) Lantern.

The use of crude molasses as a sticker to entangle the adults as they emerge and during oviposition. This stage of the life history is stressed, thus making possible the control methods. "Blackleaf 40" also showed some promise during the emergence period, while fumigation with cyanide and carbon disulphide gave negative results.

"Injury to Structural Timber by Lepidopterous Larvæ," by T. E. Snyder, Washington, D. C. (5 minutes.)

"Life History Notes on the Carpenter Worm (*Prionoxystus robiniæ*) with a New Method of Control," by H. E. Burke, Los Gatos, Calif. (5 minutes.)

Final Business

Report of committee on auditing.

Report of committee on resolutions.

Report of committee on membership.

Report of other committees.

Nomination of Journal officers by advisory committee.

Report of committee on nominations.

Election of officers.

Miscellaneous business.

Fixing the time and place of next meeting.

Final adjournment.

Wilmon Newell, *President*,
Gainesville, Fla.

A. F. Burgess, *Secretary*,
Melrose Highlands, Mass.

JOURNAL
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OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

VOL. 13 FEBRUARY, 1920 No. 1

Proceedings of the Thirty-Second Annual Meeting of the American Association of Economic Entomologists

The thirty-second annual meeting of the American Association of Economic Entomologists was held in the Girls Gymnasium, Soldan High School, St. Louis, Mo., December 31, 1919, and January 1 and 2, 1920.

The meeting was called to order at 10.20 a. m., December 31, by President W. C. O'Kane, and the annual reports and preliminary business was transacted during that session. In the afternoon of the same day, a program of papers was presented and the annual address of the President was delivered at 2.30 p. m. On the same evening, the Section on Apiculture held its meeting when papers were presented and three reels of moving picture films were exhibited. The Association resumed its sessions on Thursday morning, January 1, and in the afternoon the Section on Horticultural Inspection presented its program.

On Thursday evening a dinner was held at the Missouri Athletic Club, at which over eighty entomologists were present. At the close of the dinner President O'Kane introduced Dr. Howard who presided in a very agreeable way. He read a letter that he had recently received from Dr. Josef Jablonowski, from Budapest, which was a pleasant surprise to all the members present. He also introduced past presidents Forbes, Osborn, Marlatt, Felt, Britton, Parrott and Ball, who responded with appropriate remarks.

Mr. Arthur Gibson, the only entomologist present from Canada, was called on and made an appropriate response.

The occasion throughout was a very pleasant one for all the members.

The Association program was continued on Friday morning, January 2, and in the afternoon papers were presented and the business session was held.

The business proceedings form Part I of this report and the addresses, papers, and discussions Part II.

The proceedings of the Section on Apiculture and on Horticultural Inspection will be prepared and published by the Sectional Secretaries as part of this report.

PART I. BUSINESS PROCEEDINGS

The meeting was called to order by President W. C. O'Kane, at 10.20 a. m., Wednesday, December 31, 1919. About 150 members and visitors attended the sessions. The following were present:

C. N. Ainslie, Sioux City, Iowa.
George G. Ainslie, Knoxville, Tenn.
R. H. Allen, Boston, Mass.
William J. Baerg, Fayetteville, Ark.
E. D. Ball, Ames, Iowa.
G. G. Becker, Fayetteville, Ark.
G. M. Bentley, Knoxville, Tenn.
S. W. Bilsing, College Station, Texas.
R. A. Blanchard, Webster Groves, Mo.
W. E. Britton, New Haven, Conn.
A. F. Burgess, Melrose Highlands, Mass.
S. C. Chandler, Carbondale, Ill.
R. N. Chapman, Minneapolis, Minn.
LeRoy Childs, Hood River, Ore.
T. D. A. Cockerell, Boulder, Colo.
Mel. T. Cook, New Brunswick, N. J.
E. C. Cotton, Columbus, Ohio.
J. J. Davis, Riverton, N. J.
George A. Dean, Manhattan, Kan.
M. L. Dean, Olympia, Wash.
O. D. Deputy, Laredo, Texas.
E. H. Dusham, State College, Pa.
E. P. Felt, Albany, N. Y.
H. L. Flackler, Knoxville, Tenn.
W. P. Flint, Urbana, Ill.
S. A. Forbes, Urbana, Ill.
S. B. Fracker, Madison, Wis.
B. B. Fulton, Corvallis, Ore.
Arthur Gibson, Ottawa, Canada.
P. A. Glenn, Urbana, Ill.
James C. Goodwin, Gainesville, Fla.
H. A. Gossard, Wooster, Ohio.
J. E. Graf, Puente, Cal.
Samuel A. Graham, St. Paul, Minn.
D. W. Grimes, Agricultural College, Miss.
R. W. Harned, Agricultural College, Miss.
Leonard Haseman, Columbia, Mo.
W. P. Hayes, Manhattan, Kan.
T. J. Headlee, New Brunswick, N. J.
Glenn W. Herrick, Ithaca, N. Y.
E. J. Hoddy, Knoxville, Tenn.
H. E. Hodgkiss, State College, Pa.
W. A. Hoffman, Washington, D. C.
W. E. Hoffmann, Lawrence, Kan.
W. J. Holland, Pittsburgh, Pa.
W. O. Hollister, Kent, Ohio.
J. L. Horsfall, Dubuque, Iowa.
J. S. Houser, Wooster, Ohio.
L. O. Howard, Washington, D. C.
H. B. Hungerford, Lawrence, Kan.
H. G. Ingerson, Columbus, Ohio.
Dwight Isely, Washington, D. C.
V. L. Kellogg, Washington, D. C.
E. G. Kelly, Manhattan, Kan.
C. H. Kennedy, Columbus, Ohio.
H. H. Kimball, Agricultural College, Miss.
J. L. King, Harrisburg, Pa.
E. J. Kraus, Madison, Wis.
J. M. Langston, Agricultural College, Miss.
W. H. Larrimer, West Lafayette, Ind.
F. H. Lathrop, Corvallis, Ore.
R. W. Leiby, Raleigh, N. C.
R. N. Lobdell, Agricultural College, Miss.
Stewart Lockwood, Agricultural College, N. D.
C. L. Marlatt, Washington, D. C.
J. W. McColloch, Manhattan, Kan.

C. L. Metcalf, Columbus, Ohio.
Z. P. Metcalf, West Raleigh, N. C.
J. H. Montgomery, Gainesville, Fla.
Edna Mosher, Albuquerque, N. M.
Henry Ness, Ames, Iowa.
Wilmon Newell, Gainesville, Fla.
F. M. O'Byrne, Gainesville, Fla.
W. C. O'Kane, Durham, N. H.
Herbert Osborn, Columbus, Ohio.
Raymond C. Osburn, Columbus, Ohio.
F. B. Paddock, Ames, Iowa.
H. R. Painter, Webster Groves, Mo.
J. R. Parker, Bozeman, Mont.
R. R. Parker, Bozeman, Mont.
P. J. Parrott, Geneva, N. Y.
Edith M. Patch, Orono, Me.
L. M. Peairs, Morgantown, W. Va.
F. C. Pellett, Hamilton, Ill.
Alvah Peterson, New Brunswick, N. J.
W. D. Pierce, Denver, Colo.
W. A. Price, Lafayette, Ind.
George H. Rea, Ithaca, N. Y.
H. J. Reinhard, College Station, Texas.
W. A. Riley, St. Paul, Minn.
J. M. Robinson, Auburn, Ala.
A. G. Ruggles, St. Paul, Minn.
W. E. Rumsey, Morgantown, W. Va.
V. I. Safro, Louisville, Ky.
J. G. Sanders, Harrisburg, Pa.
E. R. Sasscer, Washington, D. C.
A. F. Satterthwait, Webster Groves, Mo.
W. J. Schoene, Blacksburg, Va.
E. E. Scholl, Austin, Texas.
V. E. Shelford, Urbana, Ill.
Franklin Sherman, Jr., Raleigh, N. C.
F. L. Simanton, Benton Harbor, Mich.
O. I. Snapp, Agricultural College, Miss.
E. W. Stafford, Agricultural College, Miss.
Frank Stirling, Gainesville, Fla.
K. C. Sullivan, Columbia, Mo.
M. H. Swenk, Lincoln, Neb.
M. C. Tanquary, Manhattan, Kan.
L. R. Taft, East Lansing, Mich.
F. L. Thomas, Auburn, Ala.
James Troop, Lafayette, Ind.
W. R. Walton, Washington, D. C.
H. R. Watts, Knoxville, Tenn.
R. L. Webster, Ithaca, N. Y.
C. A. Weigel, Washington, D. C.
R. D. Whitmarsh, Milwaukee, Wis.

President W. C. O'Kane: The meeting will please come to order. We will listen to the Secretary's report.

Secretary A. F. Burgess: Before reading the report, I would like to make a short statement which may be of interest to some of the members.

Sixteen years ago this Association met at St. Louis. This was the first year that the speaker acted as your Secretary. At that meeting, the records show that there were on the rolls 91 active, 43 associate and 41 foreign members, or a total membership of 175. The present membership is 566, which indicates how we have grown. At the St. Louis meeting sixteen years ago, 29 members were present. Today over 100 have registered.

REPORT OF THE SECRETARY

At the time of the Baltimore meeting, the total membership of the Association was 553; active 164, associate 340, and foreign 48. At that meeting, one active and four associate members resigned, and 53 were transferred from the associate to the active roll. During the year, 17 associate members have been dropped and one associate and one foreign member have died. Thirty-seven associate members were elected at the Baltimore meeting and one was reinstated. The present membership totals 566, and includes 216 active, 303 associate, and 47 foreign. The net gain for the year has been 13 members.

May 21, 1916, Prof. A. Porchinski, Minister of Agriculture, Petrograd, Russia,

died. He has been a foreign member of this Association for many years, but the news of his death was received recently.

On September 30, 1919, Patricio P. Cardin, an associate member of this Association, died as the result of an operation for kidney trouble. He was a graduate of the Massachusetts Agricultural College, and had been carrying on entomological work in Cuba for a number of years. His early death was deeply regretted by all those who were acquainted with him and the work which he was carrying on.

The Pacific Slope Branch of this Association held its fourth annual meeting at Mission Inn, Riverside, Cal., May 28, 1919. Forty-seven members and visitors were present. There was the largest attendance at this meeting of any that has been held by this branch. An excellent program was presented which is printed in full in the August number of the JOURNAL.

During the past year a number of copies of Banks index to the literature of Economic Entomology have been sold. The expenses in connection with this project have been very light, so that it has been possible to return $200 to the Association fund. At the present time the index account owes the Association fund $100, and if sales continue throughout the coming year, it should be possible to pay back this amount.

The honor roll of the members of the Association who served in the Great War was published in the February issue of the JOURNAL. Since that time the Secretary has been advised of two members whose names did not appear on that roll, namely: Albert Hartzell, who served in the United States Army, and George H. Corbett, who served as a lieutenant in the British Army. It is regretted that the information was not at hand so that these names could have been placed on the original roll when it was published.

THE JOURNAL OF ECONOMIC ENTOMOLOGY

At the Baltimore meeting, a special committee was appointed to consider the financial situation in connection with the JOURNAL. This committee reported that the JOURNAL should be kept at approximately the same size as during the previous year; that authority be given to use $500 from the general funds of the Association, if this amount was necessary, and to secure contributions amounting to $100, the same to be repaid in subscriptions to the JOURNAL in future years. These recommendations of the committee were adopted by the Association and it was voted that the price of the JOURNAL, beginning with the year 1920, be fixed by the executive committee of the Association. During the meeting, $160 was subscribed by members for the JOURNAL fund. Of this amount, $60 was paid in during the year, and advance subscriptions have been credited to each subscriber. The executive committee of the Association considered the financial condition of the JOURNAL early in the year, and voted to increase the price $1.00 to all subscribers, beginning January 1, 1920.

During the year 1918, 494 pages were published in the JOURNAL; in 1919, 478 pages were printed. The subscription list has increased materially during the past year, and an unusually large number of back numbers have been sold. This is principally due to the fact than an increase of $1.00 a volume on back numbers will go into effect on January 1, and because a considerable number of foreign subscribers have purchased back numbers.

During the year, the Secretary has transferred from the Association funds to the JOURNAL fund, $250, and with the amount paid in by members who contributed at the last annual meeting, the funds have been sufficient to carry the JOURNAL through the year with a comfortable balance. The future of the JOURNAL would be assured and it would probably now be on a self-supporting basis were it not for the fact that the cost of printing has just been advanced 25 per cent. This is our largest single item of expenditure and an advance at this rate on our present subscription list means an increase in cost of production of at least 75 cents for each subscriber.

Owing to this condition and to the probability that further increases in cost of producing the JOURNAL may be made at any time without notice, it is recommended that authority be given to increase the price of the JOURNAL on or before July 1, 1920, if conditions during the first half of the coming year appear to make this course necessary. Any increase in rate during the year 1920, would, of course, not be effective until January 1, 1921.

ASSOCIATION STATEMENT

Balance in Treasury, December 10, 1918		$605 17
By amount received from dues, 1919		616 42
By amount received from interest in Malden National Bank		10 58
By amount received from interest, Melrose Savings Bank		14 60
By amount received from interest $100 Liberty Bond		4 25
By amount received from Index fund		200 00
Paid stenographic report of 1918 meeting	$113 78	
Buttons, 1918 meeting	11 14	
Postage	58 74	
Printing programs, etc	81 25	
Telegraph and express	7 28	
Expenses of membership committee	3 90	
Expenses of Pacific Coast Branch	22 45	
Transfer to JOURNAL account	250 00	
Clerical work, Secretary's office	49 00	
One-half salary of Secretary	50 00	
	$647 54	
Balance, December 8, 1919	803 48	
	$1,451 02	$1,451 02
Balance deposited as follows:		
Melrose Savings Bank	$172 02	
Malden National Bank	631 46	

JOURNAL STATEMENT

Balance in Treasury, December 10, 1918		$94 91
By amount received from subscriptions, advertising, etc.		2,413 46
By amount received from Association fund		250.00
By amount received from interest on bank deposit		5.07
By amount received from members, advanced payments		60 00
Paid for postage	$55.53	
Paid for insurance	18 70	
Paid for printing	1,828 52	
Paid for half-tones	232.64	
Return on subscriptions	19 73	
Salary, Editor	100 00	
Clerical work, Editor's office	75 00	
One-half salary of Secretary	50.00	
Clerical work, Secretary's office	50.00	
	$2,430 12	
Balance, December 8, 1919	393.32	
	$2,823 44	$2,823.44
Balance deposited in Malden, Mass., National Bank	$393.32	

Index Statement

Balance in Treasury, December 10, 1918		$46 92
By amount received from sales to December 1, 1919		223 35
Paid for cartons	$19.85	
Postage	6.00	
Insurance	18.70	
Transfer to Association fund	200.00	
	$244.55	
Balance, December 8, 1919	25 72	
	$270 27	$270.27
Balance deposited in Malden, Mass., National Bank.	$25.72	

Summary

Balance on Index Account	$25 72
Balance on Journal Account	393 32
Balance on Association Account	803 48
One 4½ per cent Liberty Bond	100 00
	$1,322 52

Respectfully submitted,

A. F. Burgess, *Secretary.*

On motion the report of the Secretary was accepted and the financial part referred to the auditing committee.

President W. C. O'Kane: I will now read the report of the Executive Committee.

REPORT OF THE EXECUTIVE COMMITTEE

European Corn Borer

Members of the Executive Committee have been actively interested in furthering efforts to secure from Congress adequate funds with which to prosecute the campaign against the European Corn Borer.

In this work your President felt it his duty to assist in whatever way lay in his power. With that intent he visited Washington several times in the early part of this year, in order to help set before Congressional committees the judgment of our Association as to the urgent need for adequate funds, and to further the efforts of the Bureau of Entomology to secure such funds. In carrying out this plan conferences were held with officers of the Bureau of Entomology and with members of the Senate and the House. A special meeting of the Senate Committee on Agriculture was arranged by means of which the resolution adopted by this Association at its last meeting, together with other information, was brought officially before the Committee and placed in the records. Through the joint efforts of your officers, with the American Plant Pest Committee, officers of the Bureau of Entomology and the Secretary of Agriculture, additional appropriations were set under way, but were lost in the filibuster which ended the Congress that adjourned last spring.

National Research Council

In February a communication was received from the National Research Council

asking the nomination of one of our members to represent this Association as a member of the Council in the Division of Biology and Agriculture.

With the approval of the Executive Committee the President nominated Mr. P. J. Parrott, as the Association's representative. Mr. Parrott accepted the appointment and has instituted measures of great interest and value to the profession.

It is recommended that the Association provide for regular and permanent representation on the Council by electing a member to serve as its representative for a term of three years, election for such term to take place at this meeting in the regular order, after nomination by the nominating committee.

Salaries in Entomology

The fact that most professional men whose income is in the form of a salary are hard pressed by the increased cost of living is too well recognized to need proof. The condition prevails through practically all salaried positions except those of a commercial nature.

Teachers and experimenters have probably suffered more than any other class through this unfortunate state of affairs. This is for several reasons. Their salaries were relatively low ten years ago, before the rise in costs began. They have necessary living and professional standards to maintain. Their work is of such nature that an outside income of a substantial character is not usually possible.

The actual increase in cost of living in the past five years cannot be set down in definite and final figures. This is in part because commodity prices vary in different parts of the country, in part for the reason that the proportion to which a given article enters into the living expenses of a family varies. The rise in price of these several different articles has been in different degree.

In a prior study that was made by your President in another capacity a year ago, a comparison was drawn between college salaries in general in 1898 and those of 1918; and a further comparison between commodity prices in those two periods. In arriving at living costs, information was asked of various economic authorities. The average of their statements indicated that the dollar which was worth 100 cents in 1898 was worth only 45 cents in 1918. The figures as to salary were secured by a request sent to college authorities. The result of this indicated that the average, reasonably competent head of department received approximately $2,000 in 1898 and approximately $3,000 in 1918. In other words in the course of that twenty-year period, living costs had increased considerably over 100 per cent while salaries had risen 50 per cent.

Taking a more recent period, for comparison and setting up on one hand the living costs of five or ten years ago and on the other hand those of the current year, it seems reasonable to state that for the salaried professional man the cost of living in that time has doubled.

In a discussion of this subject, recently printed and distributed by Harvard University in the course of its campaign for increased endowment, the following statements occur:

"The fact is that this ideal toward which Harvard has striven during nearly three hundred years is less likely now of attainment than ever before. Because of underpayment of the teaching staff, Harvard is threatened with the loss of some of her brilliant men and with increasing difficulty in replacing them with teachers of equal calibre.

"When a man becomes a teacher, he does not look forward to the accumulation of a fortune. His dominant motives are love of teaching and devotion to the aims of scholarship. He must, however, have a material basis for the realization of his ideal, namely, a competence sufficient to insure a living conforming to the modest

standards of academic life, the means of enjoying family life, and a reasonable provision for the assistants and the equipment necessary for the economic use of his time and energy."

The scale of salary prevailing in the Faculty of Arts and Science at Harvard University is given as follows:

Instructors, $1,200 to $1,500; assistant professors $2,500 to $3,000; professors $4,000 to $5,500.

The booklet issued by the University further says:

"On this salary basis teachers at Harvard with the highest scholarly attainments and with unusual teaching ability cannot afford to remain today unless they have private incomes or earn money by outside work.

"It is safe to say that 90 per cent of the teachers at Harvard cannot live, without personal sacrifice, on the salaries paid them for teaching.

"Harvard may expect loyalty from her teachers, but she should not expect economic martyrdom.

"The young scholars, who should be the professors of tomorrow, stand between two alternatives. One is three years of additional labor and a considerable investment before they can become Doctors of Philosophy and thus qualify as university teachers. The other is the world outside the college. . . . They see at the end of seven years of study $1,200 a year, slow advancement and a station in the economic scale lower than waiters, policemen, chauffeurs or street cleaners."

The salary scale now prevailing at Harvard University, which is the subject of the above statements, is materially larger than that in effect in a large proportion of our colleges and universities or in our state or federal bureaus. Living costs in Cambridge, Mass., are approximately the same as those in some other localities and are larger than costs in the middle west and the far west. The condition of teachers and experimenters, as described in the Harvard publication, obviously applies in general elsewhere. The following letter is one among several received by your Executive Committee along with replies to their questionnaire:

"Since living costs have risen and neither state or federal service can or will pay enough to cover even a small part of this increased cost, there seems no other road open but to enter the commercial field. This presumes that one must be proficient in some other line or profession But when a man can step into another line of work, at a salary larger than he can get after twelve years of successful work in his chosen line, it's time to wake up."

The present condition is, no doubt, as fully recognized by administrative officers as by the teachers and experimenters themselves. Such recognition is the basis of the efforts to raise large endowment funds now in progress in several of our universities. Unfortunately, it is not likely that such efforts can be duplicated in similar degree throughout all institutions that employ scientific men. In addition there are large numbers who are employed by various governmental and state departments.

The profession of entomology is sharing in the salary problem. The inevitable effect is to injure the profession itself in serious degree and to darken the horizon for the men who are engaged in it. Young men of promise are attracted to other lines of work. Capable men now in the profession leave it. Large numbers who have already spent a part of their lives in the profession find their energies scattered and their efficiency diminished. Furthermore, as the months passed during this current year commodity prices have increased instead of decreasing and the difficulty has grown increasingly acute.

In this state of affairs your Executive Committee desired to perform whatever service might helpfully and constructively assist toward a betterment of conditions for entomologists. With that intent and with the assistance of a special committee

a questionnaire was sent, in August, to all members of the Association. The purpose of this was to disclose accurately the condition of salaries throughout the profession and to solicit the judgment of members as to the amount of increases that should take place.

The questionnaires were returned by 260 men engaged in the profession of entomology. Geographically the replies represent forty states, the District of Columbia, the Dominion of Canada, Mexico, the Canal Zone and the Territory of Hawaii.

All replies were divided into three classes, as follows:

Class I. Men who are at the head of a department or important division of work. This includes department heads in colleges and experiment stations, state entomologists, chief state inspectors, and men in charge of divisions in the Bureau of Entomology and in the Dominion Service.

Class II. Men not officially the head of a department but responsible for an important and well-defined section of work. This includes associates in our larger departments Under this is included, also, men employed by the Federal Bureau and in charge of sub-stations.

Class III Men who are doing the work of assistants

It is appreciated that the above divisions cannot be considered as definite lines of demarcation. Many assistants carry a large measure of responsibility In each of the three classes the actual amount of responsibility and general nature of the work vary with different individuals.

Assuming the above classification and omitting a few replies from men who have lately changed their position or who could not be classified for other reasons, there are found to be sixty-seven replies in Class I, sixty-six in Class II and one hundred and fifteen in Class III.

Class I

Of the 67 men in this class 34 are doing teaching as a part or all of their work; 35 have experiment station duties; 32 are in state departments in whole or in part; 22 are in federal employ.

The average total compensation in this class, including house rent or other additional compensation prevailing in a few instances, is $3,014.91.

The average annual vacation enjoyed by men in Class I is 27 6 days; 63 per cent of these men are allowed time in which to attend professional meetings, expenses being paid in varying degree or not at all; 29 per cent are permitted time in which to do graduate work. Four men receive full pay while doing such work. The rest receive half pay or none at all.

The average years of service spent by the men in this class in official entomological work is 18.6. The average years spent in their present position is 11.9 The average years of college preparation before taking professional position is 5 7 years.

Class II

In Class II, 66 replies are tabulated; 11 of these men are doing teaching; 17 are doing experiment station work; 10 are in state departments or are doing inspection service; 44 are in the federal service

The average total salary received by men in Class II, including outside compensation, is $2,069.73.

The average annual vacation allowed is 23.3 days. Of these men 22.7 per cent have opportunity to attend annual meetings, but only a part of these can draw their traveling expense on such attendance. In this group 10.6 per cent are allowed time for graduate work and of these one draws full pay while doing such work.

The average number of years that these men have been engaged in professional

work since completing their training is 10.4 years. The average number of years spent in present position is 6.4 years. The average number of years spent in college preparation is 5.4 years. The average mimimum salary desired by men in this group is $3,024.

Class III

One hundred and fifteen replies are included in the returns under Class III. Of these, 17 are doing some teaching; 24 are doing experiment station work; 36 are in state departments or inspection work; and 60 in the employ of the Federal Bureau.

The average total salary now received in this class is $1,704.

The average annual vacation is 20 days. Of the men in this class 17.3 per cent are allowed time in which to attend annual professional meetings, but of these only four receive their expenses at such meetings. Leave of absence for graduate study is allowed to 13.9 per cent.

The average number of years that the men in this group have already spent in professional work is 6.7 years. The average length of time that they have occupied their present position is 4.1 years. The average length of time spent in undergraduate and graduate training is five years.

The average minimum salary desired by men in this group is $2,419.

The committee recommends that the data herein set forth be delivered to the committee on resolutions for recommendation at the final session.

W. C. O'Kane,
A. G. Ruggles,
H. J. Quayle,
E. C. Cotton,
W. E. Britton,
A. F. Burgess,
Committee.

It was voted that the report of the Executive Committee be accepted and the recommendations be adopted.

President W. C. O'Kane: The next is the report of the Employment Bureau, which will be read by the Secretary.

REPORT OF ENTOMOLOGISTS' EMPLOYMENT BUREAU FOR YEAR OF 1919

Auburn, Ala., December 24, 1919.

During the past calendar year the work of the Employment Bureau has reflected "after the war" conditions in many ways. Numbers of men who had been in army service returned to civilian life and a number of these sought the service of the Bureau in locating employment again. Many who are known to be "out of service" have failed to inform the Bureau of their new addresses and we are unable to get into communication with them again as we would like to do. In June, 1919, fewer of the newly graduated men enrolled than usual. Naturally there are many more calls for men who are starting work at comparatively low salaries than for the highly paid positions. The scarcity of men available in the lower class has, therefore, made it impossible for us to furnish names as desired by employers in a number of cases. Many of the men who would seem to be starting in entomological work indicate minimum salaries that they will consider which are much higher than has been the case in previous years. There are many indications that employers of entomologists must provide higher salary rates than formerly as is being done in most other professions and occupations.

During the year, 19 men have enrolled, of which number two are "reënrollments" indicating that men who have received 10 references through the Bureau, although they have not been placed in a new position thereby, are so well satisfied that they wish to continue the services of the Bureau. Undoubtedly in very many cases the prospect of a new position has led to the offer of increased salaries to hold desirable men in the positions which they already occupied.

There are now about 70 names on the rolls of the Employment Bureau. During the year, at least four men have been placed in new locations through the work of the Bureau, and possibly others of whose appointments we have not been informed Altogether 83 references have been given requiring considerable time and correspondence.

The balance of "cash on hand" has shown a slow but steady increase since the beginning of the Bureau work. Accordingly, I would ask the Association to take action indicating whether they desire to have a policy adopted of increasing the number of references given for one enrollment fee beyond the 10 now given for the fee of $2, or if this seems to be a reasonable and satisfactory service, to decide whether, as a slight compensation to the person in charge of the Bureau, the sum of 10 cents per reference shall be set aside so long as, and *only when*, there shall be funds on hand to meet first and fully all other expenses incurred ordinarily in the conduct of the Bureau work. Hitherto the services of the men in charge have been given entirely gratis and only stenographic assistance has been paid for.

The financial statement is attached hereto:

Financial Statement for 1919

Receipts:		
December 24, 1918, to cash balance on hand	$43 30	
To 19 enrollment fees at $2	38 00	
Total		$81 30
Disbursements:		
By stenographic service (voucher 1)	$16 30	
By postage (voucher 2)	4 07	
By stationery (voucher 3)	2 00	
Total		22 37
Balance, cash on hand, December 24, 1919		$58 93

(*Note.*—Check for cash balance is attached hereto and payable in case the Association desires to transfer the administration of the Bureau to any other party, as I would personally be glad to have done.)

Respectfully submitted,

W. E. Hinds, *In Charge*.

St. Louis, Mo., December 31, 1919.

We, the auditing committee, have examined the report herewith submitted and find it correct.

E. G. Kelly,
J. S. Houser,
Auditing Committee.

Mr. E. P. Felt: I think it would be desirable to accept the report with the modification that the modest compensation mentioned

be allowed and that the financial part be referred to the Auditing Committee.

A motion was made to that effect and it was so voted.

SECRETARY A. F. BURGESS: At the close of the report, Dr. Hinds stated that he would like to be relieved of conducting the Employment Bureau. For the information of the members, I will say that the director of the Employment Bureau is not elected annually by the Association, but serves without a definite term of office. It seems to me that as a matter of good policy, arrangements should be made for having a definite term of office for the director of the Bureau. This is no reflection on Dr. Hinds or his work, but simply a matter of good business policy. Possibly this could be referred to the committee on resolutions for adjustment.

PRESIDENT W. C. O'KANE: We will now hear the report of the Committee on Nomenclature.

REPORT OF THE COMMITTEE ON NOMENCLATURE

Out of the total number of common names of insects submitted to the committee by different members of this Society the following list has been prepared and recommended for consideration and adoption. A few of the names presented were not included by the committee for various reasons, perhaps the larger number being excluded on account of the use of the generic name as a common name.

In addition to the list of names submitted the committee makes two general recommendations for your consideration: (1) that the term *grasshopper* be substituted for *locust* when writing of any species of grasshoppers; and (2) that the term *aphid* be substituted for *aphis* when discussing any species of *aphids*.

The committee also recommends the adoption of the following changes in the names of two common pests:

Alfalfa leaf-weevil to alfalfa weevil—*Phytonomus posticus* Gyll.
Harlequin cabbage bug to Harlequin bug—*Murgantia histrionica* Hahn.

Finally, the committee recommends the publication in the Proceedings of the names in this list that are adopted together with all of the common names that have been presented in the ten previous lists:

Argentine ant—*Iridomyrmex humilis* Mayr.
Australian-pine borer—*Chrysobothris impressa* Fab.
Banana root-borer—*Cosmopolites sordidus* Germ.
Beautiful hickory-borer—*Goes pulchra* Hald.
Black thread-scale—*Ischnaspis longirostris* Sign.
Camphor thrips—*Cryptothrips floridensis* Watson.
Carpenter worm—*Prionoxystus robiniae* Peck.
Citrus black-fly—*Aleurocanthus woglumi* Ashby.
Cocoanut mealy-bug—*Pseudococcus nipae* Mask.
Cuban-laurel thrips—*Gynaikothrips useli* Zimm.
Elm borer—*Saperda tridentata* Oliv.
Elm sawfly—*Cimbex americana* Leach.
Elm leaf-miner—*Kaliosysphinga ulmi* Sund.
Elm case-bearer—*Coleophora limosipennella* Dup.

Gall-making Maple-borer—*Xylotrechus aceris* Fisher.
Globose scale—*Lecanium prunastri* Fonsc.
Grass thrips—*Aphanothrips striata* Osb.
Green shield-scale—*Pulvinaria psidii* Mask.
Hickory bark-beetle—*Eccoptogaster* (*Scolytus*) *quadrispinosus* Say.
Irrorate leaf-hopper—*Phlepsius irroratus* Say.
Larch case-bearer—*Coleophora laricella* Hbn.
Lilac-borer—*Podosesia syringae* Harris.
Linden-borer—*Saperda vestita* Say.
Locust-borer—*Cyllene robiniae* Forst
Mango seed-weevil—*Sternochetus mangifera* Fab.
Meadow plant-bug—*Miris dolabratus* L.
Mining scale—*Howardia biclavis* Comst.
Papaya fruit-fly—*Toxotrypana curvicauda* Gers
Pineapple black-weevil—*Metamasius ritchei* Mar
Poplar borer—*Saperda calcarata* Say.
Pyriform scale—*Pulvinaria pyriformis* Ckll.
Red-banded thrips—*Heliothrips rubrocinctus* Giard.
Saddled leafhopper—*Thamnotettix clitellarius* Say
Sericeous palm-weevil—*Metamasius sericeus* Ol
Six-spotted leafhopper—*Cicadula 6-notata* Fall.
Sugar-maple borer—*Plagionotus speciosus* Say
Sweet-potato weevil—*Cylas formicarius* Fab
Twig girdler—*Oncideres cingulatus* Say.
Two-lined chestnut-borer—*Agrilus bilineatus* Web
West Indian fruit-fly—*Anasthrepha fraterculus* Wied.

Respectfully submitted,

GLENN W. HERRICK,
EDITH M. PATCH,
Z. P. METCALF,
Committee.

Inasmuch as the recommendations in this report provided for the publication of all the common names of insects which had been adopted by the Association, a general discussion followed. It was voted that the list presented by the committee be adopted and the recommendations concerning the use of the word "grasshopper" instead of "locust" and the word "aphid" instead of "aphis," be approved and that this list combined with those names that had previously been adopted, be printed and copies reserved for sale.

PRESIDENT W. C. O'KANE: We will now hear the report of the Committee on Policy.

Mr. E. D. Ball presented the committee report. It was voted that this report be referred back to the committee to be presented in final form at the last session of the meeting.

PRESIDENT W. C. O'KANE: We will now have the report of the Committee on Entomological Investigations.

MR. GEORGE A. DEAN: In view of the fact that the Committee

on Policy has made provision for a sub-committee on entomological research and standards, and since the Committee on Entomological Investigations find that after interviewing a number of the members of the Association, they believe that this sub-committee is in a position to handle this work, your Committee on Entomological Investigations has decided to make no report. In view of the facts your committee would like to suggest that the Committee on Entomological Investigations be discontinued. This report is signed by myself as chairman, and Messrs. P. J. Parrott and W. J. Schoene. I move that the report be accepted and the matter of discontinuing this committee be referred to the Committee on Resolutions for later report.

The motion was carried.

President W. C. O'Kane: I will now call for the report of the Committee on U. S. National Museum.

REPORT OF THE COMMITTEE ON U. S. NATIONAL MUSEUM

The following information has been gathered, carefully studied and approved by your committee.

Conception of the Duties of the National Museum

The duties of the National Museum in relation to entomology are, we believe, to act as:

1. A national repository for the insect collections, the primary goal being to have as complete a representation of the fauna of the North American continent as possible, but emphasis to be placed also on the completeness of the collections from the entire world for reasons noted later. The Museum should also be a national repository for types of American species.
2. An investigational institution where the staff, Bureau of Entomology workers, other entomologists and advanced students could be provided with ample and satisfactory rooms for investigations on insects.
3. An educational institution for the laymen. This would necessitate popular exhibits illustrating the variety of insects, and the importance of their relation to human existence and interest.

The duties are indirectly stated in the 1918 Repprt of the U. S. National Museum.

Importance of Insects in Nature Study

The importance of insects to nature study is evident to everyone. The enormous number of individual species in comparison with the number of species of other animals or plants, their wonderful and remarkable variations and adaptations, and their relations and interrelations to all nature are evidence of the need of a more general knowledge of insects among laymen. This is more evident to the practical entomologist who every day realizes, from personal contact, the value of a general and correct knowledge of insects to enable the individual to comprehend and apply control measures.

Importance of Insects from the Purely Economic Point of View

Probably no other factor in nature is more closely related to human existence than are insects, with the possible exception of human diseases. The success or failure of

the fruit crop or of the wheat or corn crop may be and often is wholly dependent on the effectiveness of artificial or natural control measures. The prevalence of many human diseases is wholly dependent on the prevalence of one or another insect.

Importance of the Museum to Economic, Scientific and Popular Entomology

The systematic study of insects is directly related to all phases of entomology, indeed the foundation of all insect studies is the classification. We must know the insect before deeply engaging ourselves with the problem. In the case of newly introduced insects early recognition is of greatest importance and this fact alone justifies the building up of a collection representative of the entire world. Federal, state, experiment station, and other entomologists throughout the country depend largely on the experts working in the U. S. National Museum for identifying insects, especially those little known.

Financial Support. The National Museum supports the Division of Insects to the extent of furnishing one associate curator and two preparators which amounts to an expenditure of approximately $4,200. The Bureau of Entomology furnishes about fifteen entomologists and as many preparators, an amount approximating $39,000, whose work consists primarily in keeping the collections of the various orders and determining the material for workers of the Bureau and for entomologists elsewhere. The funds furnished by the Bureau amount to about 7 per cent of their total income for general expenses, while the amount paid by the National Museum to the Division of Insects is only 1.4 per cent of its income for the preservation of collections.[1] For the past fiscal year the Museum was allotted $300,000 for the preservation of collections. In general it might be assumed that each of the three departments of the Museum would get $100,000 Certainly the Biological Department not less since the preservation of their collections is a larger item than the similar needs of the other two departments, and since there are seven divisions in the Department of Biology we should expect the Division of Insects to receive not less than one-seventh of the total income or $14,285. On the basis of importance, from the standpoint of human interest, economically and otherwise and the needs of taxonomic work on insects this division should receive a much larger proportion of the funds available. In justice to the other divisions it should be added that the above comparison is made not to minimize the importance of any division. There is not a division of the Museum work which does not deserve all of the funds at present allotted and more.

Needs of the Museum Summarized

From a study of the Insect Division of the U. S. National Museum and personal observations and facts offered by those in a position to know, your committee summarizes the needs of the Museum as follows, listed in the order of their importance:

1. More space for workers, including students as well as regular employees, and for the collections and popular exhibits. The Museum rooms are greatly crowded, the rooms are poorly lighted, and we are informed were marked "attic" on the architect's plans and were never intended for scientific work-rooms.

2. More custodians to care for the collections and to handle the large volume of material sent in for identification. Promptness in the identification of insects has a direct bearing on the prosperity of the country since delay may result in the secure

[1] In addition to the salaries indicated the National Museum expends between $1,000 to $3,000 per year on cases, supplies, etc., bringing the total support to about $7,000, but apparently this does not reduce the per cent of total income as the National Museum budget calls for a separate appropriation for "Furniture and Fixtures," and for "books."

establishment of a serious pest in some section of the country heretofore uninfested. There should be one institution in this country with a sufficiently large number of specialists to exert a very decided influence upon our systematic work, and the National Museum is the logical institution.

3. Entomologists should be assured of sufficient space and custodians to properly and permanently care for large and small donations of specimens and regulations which will be sufficiently rigid to prevent the loss or misuse of materials. It is known that the National Museum has not secured large and irreplaceable collections, because there was little assurance that they would be cared for to the best advantage and this condition is bound to continue and the Museum will not receive collections which would otherwise be bequeathed until the Museum is able to offer the necessary facilities and safeguards.

4 Popular exhibits, already alluded to, are essential to the popularity and success of any Museum aside from the reasons already advanced for such exhibits. There is need of several specialists to prepare entomological exhibits at least comparable with similar exhibits in the larger museums of the nation

5. Funds should be available to purchase collections. Occasionally collections containing large numbers of types of American insects, or containing material otherwise difficult to secure are obtainable only by purchase

6. A systematic effort should be made to have as complete a representation of the American fauna as possible. The present force is inadequate to consider such an effort

7. Funds should be available to enable the employment of a regular collector or collectors for making collecting expeditions, first consideration to be given to completing the collections from the North American continent, but later this should be enlarged to include the entire world.

8. Proper and legitimate expansion of the Insect Division of the Museum calls for greater space and more satisfactory working quarters as already stated and with this very evident need in mind the future plans for the Museum should include the erection of a separate building for insects.

In conclusion your committee would urge entomologists to furnish the National Museum with types or cotypes of species described by them as well as duplicate representatives of groups being worked up, and to coöperate with the Museum authorities in every possible way. Your committee has every confidence in the ability of those in charge of the affairs of the Division of Insects, of the Department of Biology, and of the Museum itself, but it realizes further that they alone are powerless to institute the many needed reforms without the thorough coöperation, assistance and support of all entomologists and those interested in the welfare of entomology.

Respectfully submitted,

J. J. Davis,
V. L. Kellogg,
E. P. Felt,
Herbert Osborn,
E. D. Ball,
Committee.

Mr. J. J. Davis: I would like to offer as a member of the committee, a resolution which I think has a direct bearing and should be considered at the same time that we consider this report. The reason we believe it is well to consider such a resolution is the fact that it is going to be impossible to secure results simply by approving a report

of any committee. It is essential that we get to work, every one of us, and do everything we can to urge better facilities at the National Museum.

Resolved, That owing to the urgent needs of the Division of Insects, U. S. National Museum, the Museum Committee be empowered to join with the Museum Committee of the Entomological Society of America in preparing and printing a concise conference report based on two above mentioned committee reports, this printed report to be used for publicity purposes.

Further resolved, That the National Research Council be informed of the needs of the National Museum and the importance of the Division of Insects to every phase of entomology and their consideration of this matter and their support be urged.

Further resolved, That entomologists in all states be urged to use their influence in impressing upon their national legislative representatives the importance of this matter, also that on account of the direct and important bearing of the museum work on economic entomology of the entire United States the members of this Association be strongly urged to secure the endorsement of the State Horticultural and Agricultural Societies

After general discussion, it was voted that the report of the committee be accepted, and that it be authorized to prepare a statement to be submitted to the Association at the final business session.

PRESIDENT W. C. O'KANE: We will now have the report of the Committee on Index of Economic Entomology.

REPORT OF THE COMMITTEE ON THE PUBLICATION OF THE INDEX OF AMERICAN ECONOMIC ENTOMOLOGY

Carrying out the instructions of the last annual meeting, your committee arranged with Dr. L. O. Howard, chief of the Bureau of Entomology, for the compilation of the index for the years 1915 to 1919 inclusive, with a view of having it completed and published early in 1920.

Miss Mabel Colcord was detailed to take charge of this work and she estimates that there are now about twenty thousand references with presumably two to four thousand yet to be entered and a fair prospect of its being completed the latter part of January. Figuring on the basis of the 1905–14 index, this would mean a volume of approximately 250 pages, which agrees exactly with our estimate of a year ago.

The printer's charges for an edition of one thousand copies, 400 bound, of substantially the same character as the preceding volume, would be, at current prices, $1,550 for a volume of 250 pages. There would be some expense for author's corrections, the proofreading, postage, etc. The total cost can hardly be less than $1,800. We could not count, as with the preceding index, on selling more than 300 copies at the outset, though the probabilities are good that a large number could be sold within a five-year period.

The total cost of one thousand copies of the 1905–14 index, including the binding of three hundred (the remainder were held unbound until needed) was $1,212.99. The advance subscription rate, limited to members and to be accompanied by a remittance prior to a stated date, was fixed at $4.00 and after that the price was advanced to $5.00 for domestic and $5.50 for foreign subscriptions. There were 161 copies sold to advance subscribers and 58 additional to others prior to December 7 of that year. The receipts from sales amounted to $928.49 (including $15.51 which

remained in the index fund), leaving a balance against the work of $284.49. Up to December 11, 1919, the sales for 1919 amounted to $223.35. After paying for postage, insurance, cartons for shipping the books and returning $200 to the Association fund, there is a balance of $25.72 in reserve. The 1905–14 index fund still owes the Association $100 and if the number of sales of this year can be duplicated in the next, the indebtedness of the index will be cancelled.

The committee recommends that it be continued to supervise the completion of the index manuscript and that the editorial board of the JOURNAL OF ECONOMIC ENTOMOLOGY be authorized in its discretion to proceed with the publication of the index and to fix, as heretofore, the conditions of sale, it being expected that the terms formulated will result eventually in full reimbursement of the Association.

Respectfully submitted,

E. P. FELT,
A. F. BURGESS,
W. C. O'KANE,
W. E. BRITTON,
W. E. HINDS,
Committee.

On motion it was voted to adopt the report.

SECRETARY A. F. BURGESS: The adoption of this report carries with it the publication of the next issue of the index. In order to carry this project through, it will be necessary to secure 300 paid subscriptions from members of the Association at $4.00 each, in order to get a working fund sufficient to finance the undertaking. Before the last index was issued, 161 advance subscriptions were secured from members. It will be necessary to practically double this number in order to finance the new volume.

PRESIDENT W. C. O'KANE: I will call for the report of the Committee on Amendments to the Constitution.

REPORT OF THE COMMITTEE ON CONSTITUTIONAL AMENDMENTS

Careful consideration has been given to the proposed revisions of the Constitution, as published in the program of the thirty-second annual meeting of this Association. As the proposals involve a radical departure in the administration of the affairs of the Association, the committee is not now prepared to recommend the adoption of the proposed amendments. The committee wishes it understood that this action does not prejudice any efforts, either of a similar or different sort, that may be made in the future to promote the work of the Association as embodied in the original suggestions for the appointment of a Committee on Policy. The committee, moreover, desires to express its hearty approval of the underlying motives of the proposed revisions—to promote research, stimulate progress and encourage concentration of efforts. As the Committee on Policy has shown capacity to render great service along these lines as a standing committee and is accomplishing the ends intended, it is deemed unwise to introduce fundamental changes in the Constitution which might prove difficult to correct.

P. J. PARROTT,
GEORGE A. DEAN,
WM. A. RILEY,
Committee.

By vote of the Association the report of the committee was adopted.

PRESIDENT W. C. O'KANE: The chair will announce the following committees:

Nominations: E. C. Cotton, J. J. Davis, P. J. Parrott.

Resolutions: A. G. Ruggles, G. A. Dean, J. G. Sanders.

Auditing: E. G. Kelly, J. S. Houser.

Temporary representative to serve as a member of the council to the American Association for the Advancement of Science on account of the absence of Professor Gillette: S. A. Forbes.

PRESIDENT W. C. O'KANE: Is there any miscellaneous business?

MR. LEONARD HASEMAN: The Secretary of the Board of Agriculture is considering the desirability of reprinting the Riley reports. If the members of this Association, especially the younger ones, are interested in securing these reports, a resolution concerning them might help materially in having them published.

PRESIDENT W. C. O'KANE: As there is no motion, the matter will be referred to the Committee on Resolutions for consideration.

SECRETARY A. F. BURGESS: I would like to bring before the Association the condition in which we find ourselves in connection with the gipsy moth work in New England.

Our appropriations have remained stationary. Our problem has not decreased in size. Our expenditures have increased upon all items. Unless we have more money, we cannot do the volume of work that we should do. I have talked with Dr. Howard in regard to this matter, and he is favorably disposed to the proposal of having an additional appropriation of $100,000 for the coming fiscal year. Unfortunately this amount has been dropped from the estimates. The increased cost in wages, supplies, etc., amounts to over 30 per cent and it will probably be necessary to increase still more before the end of another year. We are paying lower than normal rates at the present time. I understand that there is a possibility that a supplemental estimate can be put in, and I would like to interest the members of this Association in the matter because we are facing a crisis in this work.

PRESIDENT W. C. O'KANE: This matter will also be referred to the Committee on Resolutions.

At the Friday morning session, at the request of the President, First Vice-President Ruggles and Past President Osborn were requested to escort Dr. Howard to the platform, where he was introduced by the President as the newly-elected President of the American Association for the Advancement of Science. He responded as follows:

Mr. President and Fellow Entomologists:

I did not expect to be exhibited this morning. I, of course, am enormously gratified at the personal compliment which the council paid me in electing me president

of the Association, but aside from the personal compliment, there is something very much stronger. It means that, as a class among scientific men, we have been coming for a long time with increasing rapidity and that we have gained by our sound scientific work the confidence of our fellow workers in other branches of science. That means a great deal. It is one thing to gain public confidence, but down in the bottom of our hearts we want the confidence in the value of our scientific work and the perfection of our methods in men who are working with other and older branches of science. I think it is not me who is to be congratulated, so much as the whole group of entomologists, economic and pure (Applause.)

Mr. H. A. Gossard, one of the representatives of this Association on the council of the American Association for the Advancement of Science, stated that he had been endeavoring to go over the lists of the Association in order to arrange for the promotion of all of our members who are entitled to receive fellowships in the American Association for the Advancement of Science.

Mr. Gossard stated that it was quite a complicated task and that it would take considerable time, hence he doubted whether it would be possible to make an entire adjustment of the matter at the present meeting.

At the afternoon session, Friday, the closing business was transacted.

President W. C. O'Kane: I will call for the report of the Auditing Committee.

AUDITING COMMITTEE

St. Louis, Mo., December 31, 1919.

We, the undersigned, as auditing committee, have examined the accounts of the treasurer of the Association of Economic Entomologists of America, of the Journal of Economic Entomology, the Index of Economic Entomology, and of the Entomologist Employment Bureau and have found them correct in every detail.

E. G. Kelly,
J. S. Houser,
Committee.

It was voted that the report of the committee be adopted.

President W. C. O'Kane: You will now listen to the report of the Committee on Resolutions.

REPORT OF COMMITTEE ON RESOLUTIONS

Your Committee on Resolutions begs leave to submit the following report, which for clarity and convenience is separated under the following heads: *Resolved,*

(1) That we express our appreciation to the local committee composed of George T. Moore, Alexander S. Langsdorf, Augustus G. Pohlman, John W. Withers and John Wulfing, who had charge of arrangements in St. Louis for the thirty-second annual meeting of the Association of Economic Entomologists.

(2) That the Secretary be authorized to prepare a suitably engraved certificate to be presented to all living past presidents, and that this presentation be established as a custom for the future.

(3) That the Employment Bureau be discontinued, and that the money be returned to those registrants who have credit with the Bureau.

(4) That since the Committee on Policy has made provision for a sub-committee on entomological research and standards, the Committee on Entomological Investigations be discontinued.

(5) That a material advance in the scale of compensation of entomological workers is essential to the present and future welfare of this important branch of science.

That the following schedule of salaries is endorsed by this Association as reasonable compensation for efficient professional services in entomology:

A. *Chief Executive:* In administrative and technical charge of a major organization, involving extensive executive responsibility, and the determination and direction of broad policies and undertakings; salary $7,500 and up.

B. *Department or Division Head:* In administrative and technical charge of a major division or department of an organization, involving full responsibility for its direction; salary $4,000 and up.

C. *Associate, or Senior Assistant:* Under general administrative direction of a department or division head, and responsible for the technical direction of a considerable subdivision; salary $3,000 and up.

D. *Assistant:* Under specific administrative direction and performing prescribed technical duties; salary $1,800 and up.

That the Association and its members earnestly urge the adoption of the above schedule throughout the country.

(6) That active membership in our Association should be maintained as an honor due to high grade work and constantly maintained interest in the furtherance of our Association and its ideals. Unless such a high standard is maintained active membership will have no significance.

(7) That this Association unites with the Entomological Society of America in the publication and distribution of a concise conference report based on the reports of National Museum committees of the two associations, calling attention to the urgent needs for greatly increased facilities for the Division of Insects.

Further, that this need be communicated to the National Research Council with an urgent plea for council support in improvement of facilities for entomology.

(8) That since we feel it necessary to the best interests of this Association and the furtherance of economic entomology in the United States, that divisional heads in the U. S. Bureau of Entomology be present and take part in our annual meetings, the Department of Agriculture can well afford to grant leave of absence on full pay, and meet the expenses of such officials for such purpose, even if it is deemed necessary to curtail the present extensive travel of minor assistants.

(9) That the phrase in the motion which established the Committee on Policy at the thirty-first annual meeting, as follows: "The originating and directing of all policies of the Association and its various undertakings" be stricken out, for the purpose of clarity and to avoid repetition.

(10) That this Association heartily approves the proposed reprinting of the Riley Missouri Reports.

(11) That inasmuch as the further spread of the gipsy moth and the brown-tail moth is a menace to the agricultural, horticultural and forestry interests of the United States, and since cost of operation has greatly increased, and thus made it impossible to conduct the work against these insects with the appropriation now available, this Association favors an additional appropriation by Congress of $100,000 for the Bureau of Entomology, to be devoted to this important work, and further, that this Association take every reasonable measure to support this appropriation.

(12) WHEREAS, The Federal Horticultural Board has, through its quarantine service, rendered valuable protection to the agricultural interests of the United States, and

WHEREAS, The present quarantine service of the Board is not at present adequate, because of insufficient funds, to properly safeguard the country against the importation of new pests, therefore, the American Association of Economic Entomologists requests Congress to appropriate and make available the sum of $200,000 for the ensuing fiscal year, for the use of the Federal Horticultural Board in extending and developing an adequate port inspection and quarantine service at all ports of the United States, and that copies of this resolution be furnished to the chairmen respectively of the Agricultural Committees of the House and Senate, the Honorable Secretary of Agriculture and the Chairman of the Federal Horticultural Board.

(13) That this Association unite with the Phytopathologists, Horticulturists and other associations in full coöperation with the American Plant Pest Committee in its publicity and legislative efforts for the protection of America from destructive plant pests.

(14) That our Association representative to the National Research Council be an ex-officio member of our Committee on Policy.

(15) That the proposition of Prof. Frank R. Lillie, Chairman of the Committee on Coöperation and Coördination of the Division of Biology and Agriculture of the National Research Council, urging this Association to coöperate with the National Research Council, be referred to our Committee on Policy with power to act.

A. G. RUGGLES,
G. A. DEAN,
J. G. SANDERS,
Committee.

The resolutions were adopted unanimously and without comment, with the following exceptions:

Resolution 3 on discontinuing the employment bureau was discussed briefly and was adopted by a vote of 22 for, 9 against.

Resolution 5 was discussed briefly and the point was made that the adoption of this resolution might have a bad, rather than a good effect, in bringing about increased compensation for entomologists. It was adopted, however, without change.

Resolution 7 was discussed briefly, the point being made that some men in the United States Bureau of Entomology did not attend the meetings of this association because they could not obtain proper authorization from the Department of Agriculture.

PRESIDENT W. C. O'KANE: Is the Committee on Membership ready to report?

REPORT OF THE COMMITTEE ON MEMBERSHIP

Your committee has given careful consideration to the matters before it, and begs leave to submit the following report:

It recommends that the fifty-one applicants be elected to associate membership as follows:

Anderson, Charles S., Arlington, Mass.
Armitage, H. M., Alhambra, Cal.
Babcock, Kenneth W., Arlington, Mass.
Bailey, Harold L., Bradford, Vt.

Bauer, Frederick, Storrs, Conn.
Blanchard, Ralph A., Webster Groves, Mo.
Brock, A. A., Santa Paula, Cal.
Chamberlain, Kenyon F., New Haven, Conn.
Chambers, Ernest L., Washington, D. C.
Cook, William C., Univ. Farm, St. Paul, Minn.
Craig, Dexter H., Arlington, Mass.
Dean, M. L., Olympia, Wash.
De Ong, E. R., Davis, Cal.
Deputy, O. D., Laredo, Texas.
Eyer, J. R., Girard, Pa.
Fackler, Harry L., Knoxville, Tenn.
Grimes, D. W., Agricultural College, Miss.
Gunderson, A. J., Cleveland, Ohio.
Hoddy, E. J., Knoxville, Tenn.
Hodson, Benjamin E., Arlington, Mass.
Hofer, C. E., Arlington, Mass.
Hoffman, William A., Washington, D. C.
Hoffmann, William E., Lawrence, Kan.
Horsfall, J. L., Dubuque, Iowa.
Kennedy, Clarence H., Columbus, Ohio.
Kimball, Hunter H., Agricultural College, Miss.
Knapp, C. W., Arlington, Mass.
Lobdell, Richard N., Agricultural College, Miss.
Lockwood, Stewart, Agricultural College, N. D.
McIntyre, Henry L., Melrose Highlands, Mass.
McMahon, E. A., Annapolis Royal, N. S.
Montgomery, J. H., Gainesville, Fla.
Mosher, Edna, Albuquerque, N. M.
Nickels, Clarence B., College Park, Md.
Nininger, Harvey H., Winfield, Kan.
O'Rourke, Francis L., Arlington, Mass.
Palmer, Ralph G., Ithaca, N. Y.
Partridge, Newton L., Newark, Del.
Price, Walter A., La Fayette, Ind.
Ressler, I. L., Ames, Iowa.
Searls, Edward L., Schaghticoke, N. Y.
Simmons, Perez, Alhambra, Cal.
Smith, Ralph H., Twin Falls, Idaho
Spencer, Herbert, West Raleigh, N. C.
Stirling, Frank, Gainesville, Fla.
Taft, L. R., East Lansing, Mich.
Taylor, Leland H., Boston, Mass
Warren, Don C., Valdosta, Ga.
Watts, H. R., Knoxville, Tenn.
Whitcomb, Warren D., Yakima, Wash.
Winchester, Harry I., Wakefield, Mass.

A circular letter was sent to each of the associate members asking those who have not already done so, to file with the membership committee, data regarding their training and experience, list of publications, and, where possible, a copy of each, so that the members of this committee may have more adequate information about the work that our associate members are doing, with a view to possible promotion to active membership. Of the 303 associate members, 161 or 53 per cent have filed statements, and 44, or 14 per cent have sent publications. The committee again asks the associate members to file such information for the future use of the committee.

Several letters have been received from associate members, criticising the policy of the Association in regard to promotions to active membership. In explanation of this policy, the committee wishes to again point out that for several years an arrangement has existed whereby all active members are eligible to be made Fellows in the American Association for the Advancement of Science, without the necessity for further investigation.

In other words, active membership means something.

It should be borne in mind that this is an association of economic entomologists. All active members through their investigations and publications, or teaching, or control work, are supposed to have added to our knowledge of the subject. There are several systematists and workers in other lines of natural science on our list of associate members; men whose training, experience and achievement are of high order. Such members, so far as scholarship is concerned, would surely be eligible for promotion, but we cannot substitute some other line of endeavor in place of that for which this Association was formed.

Where associate members neglect to file statements or publications, your committee

is not always familiar with their achievements, and this should explain why they are not selected for promotion.

Furthermore certain associate members are in arrears on the secretary's books, and for this reason even though they fulfil all other requirements, are not recommended for promotion. Notwithstanding the present high cost of living, if a man wishes to be an active member in this Association, he must pay his dues.

Your committee believes that the following 31 men have fulfilled all requirements, and recommends that they be transferred from associate to active membership:

Abbott, W. S., Vienna, Va.
Barber, E. R., New Orleans, La.
Bourne, A. I., Amherst, Mass.
Campbell, Roy E., Alhambra, Cal.
Chapman, Royal N., Minneapolis, Minn.
Childs, LeRoy, Hood River, Ore.
DeLong, Dwight M., Harrisburg, Pa.
Ferris, G. F., Stanford University, Cal.
Fink, D. E., Riverton, N. J.
Fracker, S. B., Madison, Wis.
Freeborn, S. B., Berkeley, Cal.
Gill, John B., Monticello, Fla.
Illingworth, J. F., N. Queensland, Australia.
Iseley, Dwight, Washington, D. C.
Leiby, R. W., Raleigh, N. C.
Newcomber, E. J., Portland, Ore.
Pellett, F. C., Hamilton, Ill.
Pemberton, C. E., Honolulu, H. T.
Safro, V. I., Louisville, Ky.
Scammell, H. B., Washington, D. C.
Severin, H. C., Brookings, S. D.
Severin, H. H., Berkeley, Cal.
Shelford, V. E., Urbana, Ill.
Simanton, F. L., Benton Harbor, Mich.
Tanquary, M. C., College Station, Texas.
Treherne, R. C., Vernon, B. C.
Tucker, E. S., Tallulah, La.
Weiss, H. B., New Brunswick, N. J.
Woods, W. C., Orono, Me.
Yothers, M. A., Medford, Ore.
Zetek, James, Ancon, Canal Zone, Panama.

Three members have resigned from the Association, as follows: Charles J. S. Bethune (Active), Guelph, Can.; E. B. Engle (Associate), Harrisburg, Pa.; W. E. Evans, Jr. (Associate), Knoxville, Tenn.

Professor Bethune was one of the original members of this Association. The high cost of living is given as the reason for his request. As there is ample precedent for such action in this Association, your committee recommends that he be kept on our rolls, and his dues be remitted; also, that the resignations of Messrs. Engle and Evans be accepted.

Mr. S. Marcovitch, an associate member who resigned a year ago, now asks to be reinstated, and your committee recommends that his request be granted.

The following entomologists are recommended for election to foreign membership: Charles K. Brain, Pretoria, South Africa; Gerald F. Hill, Townsville, N. Queensland, Australia; Rupert W. Jack, Salisbury, Rhodesia, South Africa.

As two associate members have paid no dues, and as nine active and thirteen associate members are in arrears, your committee recommends that the Secretary be instructed to inform such members that if they do not remit within the coming year, their names will be dropped from the rolls.

Respectfully submitted,

W. E. Britton,
T. J. Headlee,
E. R. Sasscer,
Membership Committee.

By vote of the Association the report was accepted and the recommendations adopted, which carried with it the election of the members recommended.

President W. C. O'Kane: Are there other committees to report?

ENTOMOLOGY IN THE U. S. NATIONAL MUSEUM

The day has long passed when American scientific activities could be restricted to a narrow field. Whether we regard economic needs or intellectual development, we find ourselves compelled to consider the whole range of science limited only by our resources and the powers of the human mind. In the field of entomology this involves, among other things, access to adequate collections of insects, including not only those found in North America, but the species of the whole world. The leading European countries have long appreciated such needs, and have built up collections to which Americans have to make pilgrimages when engaged in comprehensive studies of insect groups. There is no reason why we should not possess facilities for work at least equal to those of any other country. We have the greatest resources of any nation at the present time, and certainly are not lacking in the ability to carry on the work.

The species of insects are far more numerous than those of any other groups of animals; in fact the described forms exceed those of all other groups combined. Very many of them are of supreme importance and interest to man, as destroyers of our crops, as carriers of the germs of disease, as enemies of injurious forms, or as sources of some of our most important economic products. All know the value of the silkworm or honey bee, but few realize the services of the host of parasitic insects, which keeps down the enemies of our crops, and without which agriculture would be impossible. All are aware that numerous insects are injurious to plants, but comparatively few know that many of the most harmful have been introduced from abroad. The greatest danger of our crops, or even to our health, may arise from insects accidentally brought from foreign countries through the operations of commerce. The San José scale came from Asia, the cottony cushion scale from Australia. The gypsy moth, which has cost this country hundreds of thousands of dollars, is European. The cotton boll weevil, even more to be dreaded, invaded the United States from Mexico and Central America For urgent practical reasons, therefore, as well as in order to complete and organize our knowledge we need to know the insects of all countries, and to have them represented in at least one American collection. This obvious requirement cannot be met without Congressional aid. The National Museum, under present conditions, cannot possibly develop an adequate policy of entomological development. The two prime obstacles are lack of sufficient curators and lack of space. The present force, even with the great aid afforded by the members of the Bureau of Entomology, cannot arrange and classify the collections already on hand, inadequate as some of these are. Some of the men work overtime and on holidays, while help is sometimes obtained from those not officially connected with the Museum, but all these activities lamentably fail to cover the whole field. The Museum should have enough expert curators to keep classified and in order every group of insects, and to furnish identifications and other aid to economic entomologists and other workers in every state. Should the curatorial force be supplied, however, they would be helpless in the present crowded condition of the department. There is hardly room to move around, and almost no space for new cabinets. The only way out seems to be through the erection of a new building of suitable size; fireproof, but not necessarily of any great architectural pretensions.

Granting the building and the curators, with suitable rules and arrangements to ensure the proper care of all the collections, what more should be demanded? Undoubtedly collectors and students would present or bequeath their materials on a scale previously unheard of, because of the great services they had received from the Museum and their confidence in it as a repository of types and the priceless specimens. This, however, would not suffice. Funds should be available for explora-

tions, within the United States and abroad, to discover insects hitherto unknown or unrepresented in the Museum.

With curators, building, and adequate collections, we are still confronted by another urgent need. The results of the work done must be made available to scientific men in every part of the country. This can only be brought about through the creation of adequate publishing facilities, insuring the reasonably prompt appearance of each work completed. At the present time authors hesitate to undertake large monographs not knowing when they will see the light of publicity, nor indeed whether they will ever do so.

Prepared by the committees to investigate conditions and needs of the United States National Museum,

Entomological Society of America
T. D. A. COCKERELL,
HERBERT OSBORN,
WILLIAM BARNES,
WILLIAM M. WHEELER,
J. G. NEEDHAM,
Committee.

American Association
Economic Entomologists
JOHN J. DAVIS,
VERNON L. KELLOGG,
E. P. FELT,
HERBERT OSBORN,
E. D BALL,
Committee.

MR. J. J. DAVIS: The committee recommends that this report be accepted and that copies be submitted to the authorities of the Museum and requests the aid of all entomologists in the distribution of this information.

Voted that the report be accepted and the recommendations be adopted.

PRESIDENT W. C. O'KANE: We have yet to hear from the Committee on Policy.

REPORT OF THE COMMITTEE ON POLICY

Your Committee on Policy, following its appointment at the last session, promptly organized, elected a chairman, and proceeded to a consideration of the problems confronting the Association.

A preliminary canvass of the members resulted in the presentation of twenty-two more or less distinct problems for discussion.

A second canvass, in which an attempt was made to agree on a few of the more important ones for immediate consideration, was not as successful but finally resulted in an agreement on the division of the subject matter between five subcommittees, each subcommittee to proceed with the discussion and selection of important subjects within its own field.

The fields and subcommittee assignments are given below, it being understood that the chairman was to be ex officio member of each subcommittee and that the president held the same relation to those subcommittees to which he had not been regularly assigned.

1. Education: Osborn, Dean, Pierce.
2. Insect Control: Felt, Sanders, O'Kane.
3. Organization and Coöperative Relation: Sanders, Burgess, O'Kane.
4. Research Problems and Standards: Dean, Osborn, Parrott.[1]
5. Publications: Burgess, Pierce, Felt.

[1] Professor Parrott as the Association's representative on the National Research Council was asked to assist this subcommittee.

The committee, in studying the problems of entomological education, finds that there are two quite different fields to be considered. The first of these is the general teaching of the subject for the benefit of the general public whether in the public schools, colleges or extension courses. The second field lies in the training of specialists in entomology who are to be responsible not only for the instruction in this branch, but also for the imperatively necessary research which is to carry the subject beyond its present limits and to make secure its foundation in fundamental knowledge. The committee asks the assistance of all entomologists in its consideration of definite courses in entomology for the different needs. It also asks assistance in considering the desirability of fixing minimum standards of preparation, or the holding of a degree showing a certain amount of training in entomology, as a requisite to recognition as a professional entomologist.

Your committee recommends: 1. That all members of the Association be urged to give attention to the instruction now offered in secondary and rural schools in their respective localities to the end that the best possible instruction be secured under the conditions existing.

2. That extension entomology and the extension entomologist, in all institutions where such officers exist, be connected directly with the department including entomological instruction, in order to insure the closest agreement in the activities of the two fields of effort.

Through the subcommittee on research problems and standards, your committee is, at the present time, endeavoring to determine what are the major research problems and what should be the best method of attack. Your committee asks the aid and coöperation of research workers in arriving at a decision as to the problems of the greatest value or urgency. Your committee is cooperating with the National Research Council, through our representative, in the development of entomological research and its coördination with that of the allied sciences Your committee is undertaking to stimulate coöperation and coördination in research activities upon insects of regional importance. It feels that efforts of this kind wisely and conservatively directed would result in the development of regional or group projects in which the determination of the factors needing investigation and the method of attack would largely be developed in group or regional meetings, and that conferences from time to time would tend to accelerate progress.

The subcommittee on insect control began activities as a special subcommittee on the European corn borer and was subsequently reorganized with a broader function. The corn borer problem, because of its urgency, has been given special attention. One or more members of the subcommittee have taken part in most of the recent meetings, hearings and conferences in relation to this pest and have cooperated with various agencies. The committee has supported efforts to secure appropriations commensurate with the magnitude of the project, and regrets that owing to a variety of causes a comparatively small sum was appropriated by Congress. It has doubtless rendered a valuable service in other directions, though it is difficult, in view of the coöperative character of its work, to definitely list what has been accomplished.

It is the opinion of this committee that the European corn borer must still be regarded as a most important and potentially very dangerous insect in spite of the fact that developments in eastern Massachusetts last fall showed considerably less injury than in 1918, and that in New York state but one generation, with very limited injury, developed.

Serious losses may be expected, in the opinion of this committee, in eastern Massachusetts as a rule, and if the pest becomes established in the corn belt, extensive injury may result.

Furthermore, it is held that the westernmost infestations, although sparse, are a greater threat to the corn crop of the country than the larger area in eastern Massachusetts and New Hampshire.

The committee favors an energetic effort by the general government to control and, if possible, eradicate these outlying infestations by a reasonable clean-up of the infested territory, supplemented by a large scale test of the efficacy of modified cropping and the early destruction of infested corn, especially in the very sparsely infested portions of this area.

The committee also recommends comprehensive measures in eastern Massachusetts to prevent an undue multiplication of the insect and a demonstration of the possibilities of controlling it by modifications in cropping and by the adoption of such other measures as may be practical.

Furthermore a federal quarantine is recommended, restricted as to area, and applying to corn on the cob and all other portions of the plant except shelled corn or milled grain and, if possible without serious commercial disturbances, the inclusion of other plants or plant products liable to be infested and commonly transported, such as broom corn, celery, chrysanthemums and gladioli except the bulbs thereof.

Since the efficacy of the above measures depends in a very large degree upon the closest possible coöperation between federal officials and the various state agencies, it is recommended that detailed plans for control work be formulated and made public as early as possible and used as a general guide, at least for operations in the infested territory.

It is further recommended that the secretary of agriculture be asked to reconsider the situation in view of the materially changed conditions resulting from investigations of the last few months, and that he be urged to request of Congress a special appropriation of $1,000,000 to be immediately available for cleaning up the infested territories in the early spring along lines substantially as outlined above, and that the secretary be urged to advise Congress that an equal amount for corn borer work should be included in the Agricultural Appropriation Bill, this latter to be available for a continuance of operation during the next fiscal year.

In view of the probability of other potentially injurious insects becoming established in this country in spite of quarantine and other precautions, and owing to the practical difficulties of securing immediate and effective action after the discovery of such an infestation, the committee would urge the desirability of the Bureau of Entomology having an emergency or reserve fund commensurate with the importance of the project, to be used for incipient work against such pest or pests, it being expected that later operations would be contingent upon the preliminary investigations and field operations, and cared for, as in the past, by special authorization from Congress.

E. D. Ball,
W. C. O'Kane,
A. F. Burgess,
E. P. Felt,
Herbert Osborn,
W. D. Pierce,
J. G. Sanders,
George A. Dean,
Committee.

On motion, the item in the report referring to proposed appropriation for the control of the European corn borer was amended by reducing the amount to be immediately available from $1,000,000 to

$750,000, and by striking out the request for a proposed appropriation of $1,000,000 for the next fiscal year.

It was voted to accept the report of the committee as amended.

PRESIDENT W. C. O'KANE: Is the advisory committee ready to nominate officers of the JOURNAL for the ensuing year?

MR. W. J. SCHOENE: On behalf of the advisory committee, I have the following report to make:

The advisory committee of the JOURNAL OF ECONOMIC ENTOMOLOGY nominates for editor of the JOURNAL OF ECONOMIC ENTOMOLOGY, E. P. Felt; for associate editor, W. E. Britton; for business manager, A. F. Burgess.

By vote of the Association the nominees were elected.

PRESIDENT W. C. O'KANE: Next we will have the report of the Committee on Nominations.

REPORT OF THE COMMITTEE ON NOMINATIONS

For President, Wilmon Newell.

First Vice-President, H. A. Gossard.

Second Vice-President (Pacific Slope Branch), E. M. Ehrhorn.

Third Vice-President (Horticultural Inspection Section), J. G. Sanders.

Fourth Vice-President (Apiculture Section), F. B. Paddock.

Member of the Committee on Policy, W. C. O'Kane.

Committee on Nomenclature, Arthur Gibson.

Committee on Membership, A. G. Ruggles.

Committee on U. S. National Museum, W. J. Holland.

For councillors to the American Association for the Advancement of Science, T. J Headlee, G. A. Dean.

Advisory committee, JOURNAL OF ECONOMIC ENTOMOLOGY, L. O. Howard, R. W. Harned.

Representative on the National Research Council, P. J Parrott.

Respectfully submitted,

E. C. COTTON,
J. J DAVIS,
P. J. PARROTT,
Committee on Nominations.

By vote of the Association, the Secretary was instructed to cast the ballot of the Association for the nominees.

This was done and they were declared elected.

PRESIDENT W. C. O'KANE: I will request Past Presidents Britton and Felt to escort to the platform, President-elect Wilmon Newell.

MR. WILMON NEWELL: It is very difficult on an occasion of this kind to say very much. I am aware of the fact that you have conferred on me the highest honor that it is within your power to bestow. I am very deeply appreciative and I wish to assure you that I will give to the Association the best that I have, which is not very much, but

what is more important, I will try to get for you all that I can get out of somebody else. It is interesting to me that this has happened in the twentieth year of my entomological efforts. About all I can say now is that I hope all of you will be president of this Association by the time you have been at it twenty years.

PRESIDENT W. C. O'KANE: Is there any miscellaneous business?

SECRETARY A. F. BURGESS: A list has been passed around to secure subscriptions to the new index. The reduced rate of $4.00 is for members only. If we extend this rate to institutions, we immediately get into trouble with subscription agencies that handle some of our business. Any member can subscribe for as many copies of the index as he desires at the $4.00 rate, but he must pay for them personally, or if they are to be paid for by an institution, the order must state that they are for the use of a member, otherwise the full rate will be charged.

MR. J. G. SANDERS: I move that in the future we eliminate the purchase and use of numbered buttons. They are of some expense to the Association and about 20 per cent are usually used.

It was voted by the Association that this be done.

SECRETARY A. F. BURGESS: Inasmuch as we will have no more numbered buttons, I would like to ask if the Association cares to have the list of members and the list of meetings printed in the program. The program as printed with covers is more expensive than if the covers, list of members and list of meetings were eliminated. The list of members is printed largely because each member is numbered. I will take full responsibility for originating the button scheme and for printing the list of members, but I would like to know whether the association thinks the printing of this list is worth the price?

MR. J. G. SANDERS: I would like to see the list of members printed. It is very handy for reference at the meetings.

MR. E. C. COTTON: I would not like to see the list of members and list of officers and former places of meetings dropped.

By vote of the Association it was decided to print the program substantially as heretofore.

MR. H. A. GOSSARD stated that he had checked over the list of active members and that he had sent a list of those who were not fellows in the American Association for the Advancement of Science to that association so that they could be raised to fellowships, if they are in good standing on the books. He stated that he had done the best he could in the limited time at his disposal to straighten out this matter which proved to be quite complicated. He stated that he had attended many of the meetings of the council and was very glad to have had the privilege of voting for the first economic entomologist to be president of the general Association.

MR. HERBERT OSBORN: I move that the next meeting of the Association be held at the same time and place as that of the American Association for the Advancement of Science.

The motion was seconded and carried.

PART II. PAPERS AND DISCUSSIONS

Afternoon session, Wednesday, December 31, 1919, 1.30 p. m.

PRESIDENT W. C. O'KANE: The chair wishes to announce the matter of policy in regard to papers.

The time limit requested by the author will be allowed in each case and the time will not be extended unless by vote of the Association. If the author of a paper is not present when the paper is called, it will be passed to the end of the session. The papers left over will then be called in order. In the case of a paper sent in by a member who is not present, it will be read by title unless the Association votes otherwise. The chair believes that all members who attend the meetings and bring their papers should have preference over those who send them to the meeting.

I would like to announce an invitation to visit the Stark Bros., Nurseries and Orchards, at Louisiana, Mo.

We will now listen to a paper entitled, "New Facts Concerning the Habits of the Rocky Mountain Spotted Fever Tick, *Dermacentor venustus* Banks," by R. R. Parker.

THE PRESENT STATUS OF THE CONTROL OF DERMACENTOR VENUSTUS BANKS IN THE BITTER ROOT VALLEY, MONT., AND NEW DATA CONCERNING THE HABITS OF THE TICK[1]

By R. R. PARKER, *Bozeman, Mont.*

During the past sixteen years much time and money have been spent by various agencies, both medical and entomological, in the study of Rocky Mountain spotted fever, its mode of transmission, and the habits and means of control of the wood-tick, *Dermacentor venustus* Banks, the transmitting agent.

Medical science has been more interested in the etiology and pathology of the disease and the possibility of finding a cure, than in the actual control, though a few men have labored in this direction. Dr. S. B. Wolbach of Harvard Medical School, working since 1916, has suc-

[1] Contribution from the laboratory of the State Board of Entomology, Bozeman, Mont.

ceeded in demonstrating the causative agent, an organism which he considers to belong to a new group of disease agents, that is, it is neither bacterial nor protozoan. He has worked out the life history of the organism in some detail, and has recently named it. No cure, however, has yet been discovered. Four medical men have thus far lost their lives in this work, three through accidentally acquired infection. The most recent death was that of Dr. Arthur McCray, director of the State Hygienic Laboratory, during the past summer.

Entomological workers were early brought into the field by the apparent fact that the best hope of controlling the disease lay in the control of the tick which transmits it. The work was first taken up by Prof. R. A. Cooley, and later by the Federal Bureau of Entomology. The life history of the tick, and eradication measures were first worked out and actual control was initiated in 1912, the Public Health Service also coöperating.

The area of operation has gradually been extended until it now involves approximately 125,000 acres. The two federal agencies, however, withdrew in 1917, and since then the work has been carried on solely by the Montana State Board of Entomology. That control efforts have met with some measure of success is attested by the facts that considerable areas have been freed of ticks and, whereas up to twenty-five or more cases a season were the rule, during the past two years there has been but a single case in the area where the work has been conducted. The reduction in cases is attributable in part to the control work, in part to education to avoid infection, and perhaps in part to little understood natural factors. There is some reason to expect a slight increase in the number of cases during the next few years, especially in certain areas outside the control districts.

The work of control, however, is a long and tedious operation, alike to those in charge, and to the local farmers and others involved, and two questions persistently present themselves. One concerns the permanency of the results attained, the other the possibility of finding some simpler and quicker method of operation.

Permanency of results is especially to be desired, but knowledge on this point is limited by lack of knowledge of the real source of the disease among wild mammals, among which, there seems no reason to doubt, lies the real source of the disease. The question cannot, therefore, be satisfactorily answered. Questions of the susceptibility, immunity, chronic infectivity, habitat, periodical variations in abundance and distribution, and the seasonal migrations and habits of these animals are all intimately involved. Even though we may successfully eradicate the tick, it is possible that the real condition which is the very bed-rock of the trouble may be left behind. For example let us sup-

pose that a certain rodent is the medium through which the disease becomes endemic. Then, since the distribution of most rodents and their relative abundance is largely dependent upon the distribution of certain types of vegetation favorable to them, the value of the eradication of ticks and even of the particular rodent involved, is limited by the very probable facts that a certain degree of tick reinfestation is very possible and that since the natural habitat of the rodent remains, reinfestation by this rodent would also take place, with the possibility, at least, of a recurrence of the disease. On the other hand, if this rodent were known, or it might be that more than one species would be involved, steps could perhaps be taken to prevent its reappearance. In the case of certain rodents, such a course would be entirely possible and the probability of future tick reinfestation would be of negative importance.

At the present time, the methods of tick control employed are rodent destruction (directed particularly against the Columbian ground squirrel); the restriction of grazing; dipping and hand picking of stock; quarantine and cultivation. Under these measures, the minimum time to expect apparent results is three seasons, and complete eradication will take from five years on, depending upon the degree of coöperation obtained from the residents and the thoroughness with which the state can carry out its end of the control program. Hence, the chance that there may be some simpler means of solving the problem than those now in use is not only an inviting field for research, but also a very pertinent question at the present time, when there is the probability that it will be necessary to extend the work over a greatly increased area. This possibility immediately directs attention to the fact that methods of *tick control* depend upon local conditions, so that to secure the best results, variations in method, from place to place, are quite essential. The conditions which make such variations necessary are: differences in the hosts of the larval and nymphal ticks, differences in the hosts of adult ticks, differences in economic conditions, differences in the character of the vegetation and soil covering which predetermine the species and the relative abundance of the rodent hosts of the immature ticks, and finally differences in the habits of ticks, which often show considerable variation with short distances. Space does not permit that these factors be discussed, nor is it necessary, except to point out that a further expansion of the work would mean the working out of a system of control varied here and there, to adapt it to local conditions. This is a difficult thing to do, especially in a farming community. As an alternative is the possibility of finding a simpler way of checking the fever, that is, one of more general application. The latter step

has more to recommend it, and the writer believes that such a plan may be evolved by a study of disease among the wild animals, with the end in view, of eradicating from any area concerned, those rodents or other animals which permit the disease to perpetuate itself. Such an investigation has been carefully planned, and a mass of circumstantial evidence already at hand indicates the possibility that the rodents or other animals which it may be necessary to exterminate will be very few in number. If this be so, the work will eventually resolve itself into a systematic campaign against certain species of animals, and will be aimed at the actual source of the disease rather than at the control of the transmitting agent, a long process at best, desirable though it may be. Such a program would have much to recommend it over the present system of control,—it would be more rapid, more effective and less expensive; it would eliminate features of the present system which are a source of constant irritation to a certain class of residents, and under some conditions, the reduction of ticks would be fully as marked as under the present system.

Data Concerning Habits of Dermacentor venustus Banks

In spite of time which has been devoted to the study of the habits of the tick, the writer feels that knowledge of the latter is limited, and that additional study would reveal points of value. Our knowledge of larval and nymphal habits, in particular, is extremely meagre, and those of the adult tick are by no means well known or understood. The remainder of this paper, therefore, will be devoted to the presentation of a few points which the work of the past few seasons has brought out.

Tick Migration.—It has always been supposed that the movements of the adult spotted fever ticks were of very limited extent, but while carrying on studies in eastern Montana in 1917, conditions were encountered which led the writer to believe that such was not the case. Subsequent observations have confirmed this opinion. Conditions which first suggested the idea of tick migration were found in a hilly area, cut by narrow valleys from which still narrower much-branched coulees extended back into the hills on either side. The floors of the coulees varied from a few feet to several hundred feet in width, and in the middle was always a rather narrow draw which remained green and moist until late in the season. Each side of the floor gave way to a short and usually steep slope surmounted by sandstone rimrocks. Weathered rocks from the cliffs had accumulated at their bases and on the slopes below. In the clefts of the rimrocks and among the fallen rocks, deer mice, chipmunks, pack rats and cottontail rabbits,

the rodents which were found to be hosts of the larval and nymphal ticks, were found. Hence it would be supposed that this was the place the adult ticks would occur, and during the early spring months they were found in such places, in considerable numbers. In June, on the other hand, the ticks were scarce on the slopes, but abundant in the draw. At this time the slopes had become dry, but the draw at the bottom was moist, and the vegetation green and abundant. For example, in a certain coulee known as Wolf Den Coulee, which was about half a mile in length, the floor gradually narrowed from a width of about one hundred feet at its mouth, to a few feet at the upper end. On May 18, operations on the floor of the coulee failed to reveal any ticks, though they were found in abundance on the slopes at the blind end. On June 19, however, numerous ticks were "picked up" the whole length of the floor. In another coulee in which the draw was but from one to three feet wide, nearly two hundred ticks were secured in late June by dragging but a few hundred feet up the draw. Their absence here, and their abundance on the slopes above early in the season had been noted in previous operations. Similar conditions were encountered in widely separated localities. The improbability that the ticks had been dropped in these bottoms as engorged nymphs was shown by the fact that the hosts of the immature ticks inhabited not the draw, but the slopes above. The only reasonable explanation seemed to be that the ticks had gradually migrated downward, and concentrated in the bottoms. What the compelling factor was would be hard to say, though the possibility that they had migrated from the dry slopes to the moist bottoms was naturally suggested. The writer has met with similar movements in other localities however, when the moisture factor seemed to be absent. It is of interest to inquire as to what becomes of the ticks migrating to the bottoms. They were certainly not numerous there in the spring in which this work was conducted, but there is nothing to explain their absence, or to suggest that they might not have been numerous the following spring, except the fact that these draws are usually filled by rushing torrents in the early season, and very wet for some time thereafter. It is well known that this tick avoids wet places, and is not normally found there.

In 1918, when the writer took up the control work in the Bitter Root Valley, a few experiments were conducted, to see if migration actually occurred. For one experiment, a slope to the north of Big Creek near Victor, was selected. A certain trail on this slope had long been known to be heavily infested, the ticks always being found on the vegetation growing along the upper edge of the trail. Even before going to the Bitter Root Valley, my observations noted above had suggested the possibility that ticks migrated down the slope, and stopped when they

reached the trail. To prove or disprove this possibility, one hundred ticks, marked with white paint, were liberated one hundred feet above the trail on May 3, all at the same point. Unfortunately, it seemed, at the time, this whole area was burned over on May 4. One of my assistants, however, when going up the trail on May 23, found three of these marked ticks along the upper edge of the trail, these ticks having survived the fire and moved downward. The places were carefully marked, and we returned the next day, and again found the ticks, though they had changed their position up or down the trail. The two outermost were more than two hundred feet apart.

A similar experiment carried on in another place with two hundred ticks showed that a majority of ticks tend to migrate down a slope and that very few go up. Some, however, remained near the point of release during two successive seasons, 1918 and 1919. None were found more than twenty feet up the slope, nor more than two hundred and fifty feet down the slope.

The tendency of ticks to concentrate along a trail or road crossing a slope, or along the edge of cultivated land similarly situated has been observed in numerous instances, the details of which need not be recorded at this time.

As a further proof that these adult ticks move about, it may be mentioned that we often removed all the ticks from a tuft of grass on the edge of Big Creek trail, mentioned above, only to find it again infested on our next trip. The writer has also seen ticks drop from a grass blade or bush and deliberately move toward a person standing nearby.

Though the observations thus far made have only been of a preliminary nature, they have been sufficient to indicate that ticks do move about, and that the tendency when on a slope is to migrate downward, and that migration is hindered when the low vegetation is at all abundant. Under certain highly localized conditions, this fact has valuable application to control work. Other applications to the whole general problem may develop as a better knowledge is gained of the movements and the factors which control them.

A Reaction of Engorged Seeds to Light

Prof. R. A. Cooley determined some years ago that engorged immature ticks dropped from their host during daylight. During August of the past season, while feeding seed ticks on a cottontail rabbit, a chance observation developed the further fact that the rapidity of dropping could be increased or decreased by varying the degree of light intensity. By placing the infested animals in darkness dropping could be stopped, while by increasing the light intensity, the rate of dropping could be

increased, reaching its height when the animal was placed in direct sunlight.

This fact was determined in the following manner: A cottontail rabbit had been heavily infested with seeds. When they had become engorged and started to drop, a record was kept of the number dropped during each successive fifteen minute interval, the experiment having been originally started to determine at what time of day the majority of ticks dropped. After the count had been kept for several hours, it was noted that the intervals showed alternate high and low counts. The figures were too consistent to be due to chance, and an explanation was sought. The work was being conducted in a shed. The ticks, as they dropped, were being caught on two pieces of outing flannel used alternately. It was observed that one cloth was located in a patch of sunlight, which came through the shed door, the other in the shade. The high counts were from the cloth placed in the patch of sunlight. Varying the conditions from complete darkness to direct sunlight, it soon established the conclusions recorded above. It is probable that the same reaction to the intensity of light also determines the time of dropping of the engorged nymphs. In this connection a consideration of the habits of those rodents which are hosts of larval and nymphal ticks, and which are also susceptible to the disease, may be of value in understanding the distribution of infected ticks and to a certain extent of the fever itself. The factors which enter into this problem would be the time of day at which these host animals are active, that is, whether nocturnal or diurnal, the particular conditions as regards habitat under which the various periods of the day are spent, and the extent of movements when active and the character of country then sought.

Other habits of interest might well be mentioned but time has limited the discussion to those which have a possible bearing on the distribution of infected ticks and the consequent relationship to the occurrence of infection in human beings.

President W. C. O'Kane: This paper is now open for discussion.

Mr. Leonard Haseman: I would like to ask the speaker whether in any of his work he has found any other species of tick that carry fever?

Mr. R. R. Parker: I have not found other species myself, but other investigators working under laboratory conditions have found other species that carry fever. There are other species, such as the rabbit tick, which should be worked with to determine whether or not they carry the fever.

President W. C. O'Kane: If there is no further discussion, we will now listen to the paper entitled, "The Ecology of Certain Insects Which Infest Stored Food Products," by Royal N. Chapman.

THE ECOLOGY OF CERTAIN INSECTS WHICH INFEST STORED FOOD PRODUCTS

By R. N. Chapman, *St. Paul, Minn.*

(Withdrawn for publication elsewhere)

President W. C. O'Kane: The next paper is, "The Extermination of the Pink Bollworm of Cotton in Texas," by Ernest E. Scholl.

Mr. E. E. Scholl: I will read my paper first, and if there is time I will read the paper by Dr. Hunter on the same subject.

I was detained in Austin, Tex., before coming here, where I had a conference with Dr. Hunter.

President W. C. O'Kane: We have adopted a procedure by which if a man is not present to read his paper, it goes to the end of the session.

Secretary A. F. Burgess: I would suggest in this case that the paper of Dr. Hunter be read, because it forms a part of a symposium on insect extermination, and if these papers are not all presented together, the subject will be presented in a very disconnected way.

The Association voted that Dr. Hunter's paper be read by Mr. Scholl.

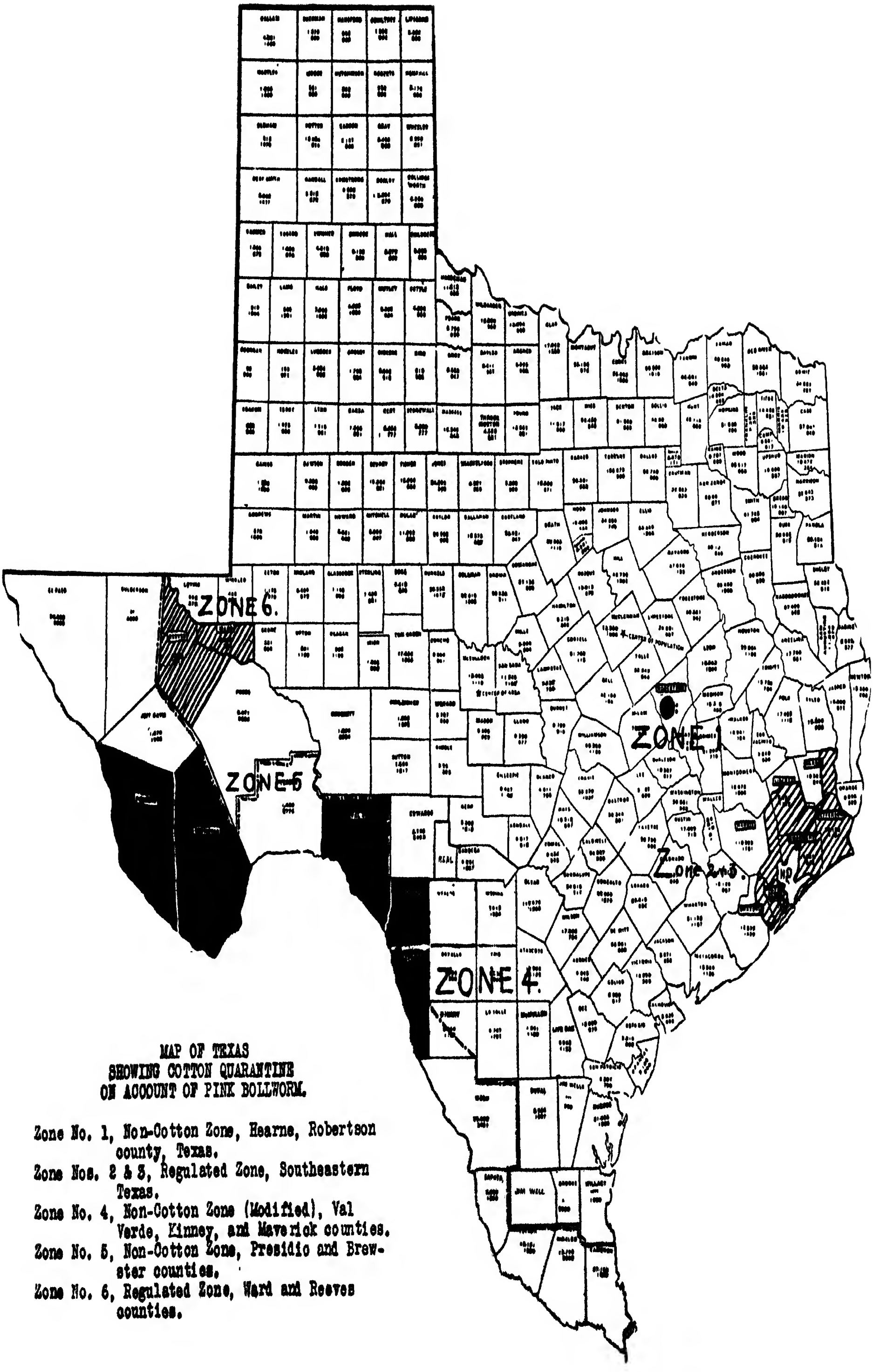
METHOD OF PROCEDURE IN PINK BOLLWORM ERADICATION WORK IN TEXAS

By Ernest E. Scholl, *Chief Entomologist, State Department of Agriculture, Austin, Tex.*

According to the opinion of the writer, the best entomological legislation in the state of Texas was the placing upon the statutes of our state of the Pink Bollworm Act, passed in October, 1917, and improved by amendments in March of 1919 as House Bill 329 and now known as the Texas Pink Bollworm Act of 1919.

The Act is very specific, and although it deals with only one species of insect, it leads us to believe that in the near future the state of Texas, as well as other states, will use the act as a basis for the enactment of similar laws pertaining to other serious insect pests.

The provisions of the act are in the main two-fold. First, provisions are made for safeguarding against the introduction of the pink bollworm from Mexico. Second, portions of the law provide for strenuous measures in controlling and eradicating outbreaks of the pink bollworm that have already become established in the state.



MAP OF TEXAS
SHOWING COTTON QUARANTINE
ON ACCOUNT OF PINK BOLLWORM.

Zone No. 1, Non-Cotton Zone, Hearne, Robertson county, Texas.

Zone Nos. 2 & 3, Regulated Zone, Southeastern Texas.

Zone No. 4, Non-Cotton Zone (Modified), Val Verde, Kinney, and Maverick counties.

Zone No. 5, Non-Cotton Zone, Presidio and Brewster counties.

Zone No. 6, Regulated Zone, Ward and Reeves counties.

As a primary safeguard the legislature created a zone known by some as a "safety zone" and termed by others a "buffer zone," which consists of a tier of counties along the Rio Grande River, and provides for this safety strip of land in which it becomes necessary for the commissioner of agriculture to use special precautions in making inspections and surveys of cotton fields. Sections of the act following that portion which provides for the above zone makes it possible, under certain conditions, to safeguard the shipments of cotton products, and if necessary, prohibit the absolute growing of cotton. The procedure in establishing a non-cotton zone in this tier of counties consists mainly of the inspection of cotton fields in Mexico by federal men, and if pink bollworms are found within twenty-five miles of the Texas border such report, when received at Washington, D. C., is reported to the governor of our state by the secretary of agriculture, after which it becomes necessary for the commissioner of agriculture of Texas to verify the infestation. After this has been done and the report has been submitted to the governor of the state, he at once issues a proclamation creating a non-cotton zone consisting of such territory as may be deemed necessary to assure the prevention of the introduction of the pink bollworm into the state of Texas. It is under this section of the act that zone 4, consisting of the counties of Val Verde, Kinney and Maverick, has become a non-cotton zone since the spring of 1918 on account of the discovery of the pink bollworm at San Carlos, Mexico, about fourteen miles from the Rio Grande River, by federal officials in the fall of 1917, and verified by state officials in February of 1918. The present existence of the pink bollworm at San Carlos makes it necessary for the continuance of non-cotton zone No. 4.

Further steps are provided in the act for the commissioner of agriculture to prevent the shipping of cotton or cotton products from border zones, or to properly safeguard such shipments by fumigation before they are shipped.

The first steps necessary in the case of discovery of the pink bollworm within the state outside of the zone provided for in Section 1 are for the commissioner of agriculture, upon receipt of a sworn affidavit from an inspector to the effect that the worms have been found, to certify such fact to the governor, who then proclaims a special zone or quarantine district to such an extent as may be determined sufficient to prevent the spread of the pink bollworm, after which it is unlawful for any grower or any person to ship cotton products of any kind without special permission from the commissioner of agriculture. It is further provided that if in the judgment of the commissioner of agriculture the danger is of such nature that the cotton must be destroyed, such fact is also certified to the governor, who then proclaims such

cotton or fields of cotton a public menace, and authorizes the commissioner of agriculture to exercise his authority in complete destruction of such cotton or cotton plants. Immediately after the issuance of such proclamation steps are taken by state and federal officials in organizing clean-up gangs, whose work consists of the uprooting of all cotton plants and picking up of all waste cotton material and the destruction of all such plants and material by burning. Quarantines with these provisions were issued by the governor for zone 1 at Hearne in the spring of 1918; for zones 2 and 3 in the southeastern part of Texas in the spring of 1918, and for zones 5 and 6 in the western part of the state in the winter of 1918–19.

Should it become necessary for the commissioner of agriculture to destroy cotton fields in which considerable cotton is still unpicked, the act provides for the appointment of an appraisal committee by the county judge of the county in which the infestations exist.

This committee consists of three disinterested citizens, and their duty is to appraise, under oath, any cotton or cotton fields that must be destroyed. The appraisal report, approved by the county judge and certified to by the commissioner, upon the receipt of a certificate from the chief inspector in charge of the clean-up work that the fields and cotton have been destroyed, finally reaches the state comptroller whose duty it is to direct the State Treasurer to issue warrants to the growers for the amount due them on the cotton destroyed. Any grower who is not satisfied with the amount assessed by the appraisal committee has the right of appeal to any court of competent jurisdiction.

Unfortunately the state legislature did not set aside a specific sum of money by which such payments as called for above can be immediately paid. Steps are now being taken by the attorney general's department of the state with a view of having all such claims paid without legislative action.

The act also provides for the condemnation of cotton fields where a very light infestation of the pink bollworm exists. Under the provisions of this section the cotton is allowed to develop and is handled under specific directions of the commissioner of agriculture, is harvested under certain rules and regulations, and is marketed under restrictions. This section also provides that any extra services rendered by the grower of a condemned field in safeguarding the cotton is entitled to compensation by the state for such services. It is further provided that the commissioner of agriculture shall proclaim rules and regulations covering the thorough destruction of all plants and for the cleaning of ground upon which infested cotton has grown, such rules and regulations shall also consist of directions for shipping cer-

tain cotton products, and rules for growing and harvesting cotton in condemned fields.

The pink bollworm law further provides that if the commissioner of agriculture deems it necessary to the protection of the cotton industry of Texas that the growing of cotton in any quarantine district or part thereof be prohibited, he shall certify such fact to the governor, who thereupon declares the growing of cotton in such area a public menace and proclaims it unlawful to grow cotton in such district for the number of years specified in the recommendation of the Pink Bollworm Commission. It makes it necessary for the commissioner to inspect such area after each crop season and have additional commission hearings for the purpose of continuing a non-cotton zone or changing the same to a regulated zone.

A section of the act provides for the proclaiming by the governor of a regulated zone in which it is permissible to grow cotton under rules and regulations by the commissioner of agriculture, embracing the planting of cotton seed from non-infested territory, beginning within the zone, marketing, and such other rules as may be deemed essential. The regulations also include the destruction of cotton fields which may be found infested in regulated zones, and provisions are made for compensation to the grower for such cotton destroyed. Compensation is not allowed, however, to any person or persons violating the proclamations, rules and regulations. Steps under this act were taken early in the spring of 1919, when it was recommended by the Pink Bollworm Commission, after holding a public hearing at Houston on April 18, 1919, that the original non-cotton zone 2 and 3 should be changed to a regulated zone. This was done by proclamation of the governor and the work of growing cotton has been supervised by state and federal officials. Pink bollworms were again found in this territory in the fall of 1919, and the cotton is now being destroyed after having been appraised by proper committees.

The act provides that the commissioner of agriculture and his authorized agents shall have the power to enter into any field or fields of cotton or upon any premises in which it may be necessary to enforce the provisions of the act. It is also provided that the commissioner of agriculture of Texas shall coöperate with the secretary of agriculture of the United States in any measures authorized and to be undertaken in preventing the introduction of the pink bollworm into the United States through the state of Texas. It has been fortunate for Texas that this clause has been inserted in the law, because of the fact that the federal government came to our rescue with men and with funds when under the circumstances the state itself could not have con-

trolled and checked the heavy infestations of pink bollworms that were found in the state in 1917 and 1918.

In the penalty clause of the act heavy fines are assessed for not reporting the presence of pink bollworms in cotton fields and for the violation of provisions of any proclamation, rules and regulations.

In the act of 1917 the placing of a certain limited quarantine or non-cotton zone was left almost entirely with the commissioner of agriculture and the governor. This created considerable dissatisfaction and the law of 1919 was so amended that it now carries a provision by which a Pink Bollworm Commission consisting of five entomologists, one designated by the governor of the state; one appointed by the State Department of Agriculture; one by the A. and M. College of the state; one by the Federal Department of Agriculture; and one appointed by the county judge in which the infestation occurs, which commission must, after having received certified reports of infestation, make investigations of such reported infestation; hold public hearings in or near the infested area and recommend to the commissioner of agriculture the nature of quarantine (non-cotton zone or regulated zone) which shall be promulgated and proclaimed by the governor. The area to be quarantined shall not exceed a distance of five miles from the outermost known infested field.

The Pink Bollworm Commission held a public hearing at Marfa, March 27, 1919, and recommended non-cotton zone No. 5 consisting of the counties of Presidio and Brewster.

A meeting was held at Pecos by the commission on March 29, 1919, and it was recommended that the infested areas at Barstow and Pecos in the counties of Ward and Reeves be placed in a regulated zone.

A hearing at Hearne, Tex., by the commission on April 17, 1919, recommended the continuing of non-cotton zone No. 1, and a final hearing at Hearne on October 15, 1919, recommended the reduction of non-cotton zone No. 1 to the city limits of Hearne, Tex.

The commission held a public hearing at Houston, Tex., on April 18, 1919, and recommended the changing of non-cotton zones 2 and 3 to a regulated zone for the season of 1919.

The commission as it now stands consists of the following members: Dr. W. D. Hunter of the federal government; Ernest E. Scholl of the State Department of Agriculture; Prof. S. W. Bilsing of the Texas A. and M. College; Mr. K. M. Trigg, planter of Bastrop, representing the governor of the state.

The county members are now being appointed for hearings at Houston, Tex., on January 6, 1920, with reference to the new infestations

in zones 2 and 3; at Eagle Pass on January 8 on zone No. 4; and at Marfa, January 10, on zone No. 5.

As further provided by law the inspection affidavits, as well as the commission reports are filed in the office of the commissioner of agriculture at Austin, Tex., where they are open to inspection by the public.

The act further provides that the commissioner of agriculture shall make adequate investigation with reference to the presence of the pink bollworm in the state and shall take prompt action to secure and maintain quarantines. For the purpose of enforcing these provisions, the commissioner may employ and prescribe such inspectors as may be necessary, and fix their compensation. An appropriation is provided for the payment of these inspectors in the services made necessary to enforce the act.

Besides the emergency clause there is a section providing that the several sections of the act shall be construed as cumulative in effect, and shall not be held to modify the provisions and restrictions or requirements of other sections. If any provisions of the act shall be declared unconstitutional, such fact shall not operate to invalidate other provisions.

In a number of test cases this act has been ruled by proper legal authority to be constitutional, and it is the opinion of the writer that under its provisions, and with the aid of the federal government, it will be possible to absolutely exterminate the pink bollworm in the state of Texas, and to prevent new infestations coming in from Mexico.

The following data will give the readers a general idea as to the location of each pink bollworm quarantine area in the state of Texas and the exact area of each of the zones:

Pink Bollworm Quarantine Proclamations in Texas

Original quarantine proclamation, zones 1 and 2	1/21/18
Quarantine proclamation, zone 4	2/19/18
Quarantine adding territory to zone 2	2/25/18
Original non-cotton proclamation, zones 1, 2, 3	2/25/18
Proclamation changing Hardin County line	3/21/18
Final quarantine proclamation	5 /7/18
Quarantine proclamation, zone 4	4 /9/19
Quarantine proclamation, zone 5	4 /9/19
Quarantine proclamation, zone 6	4 /9/19
Hearne quarantine proclamation	4/24/19
Hearne non-cotton zone No. 1	4/24/19
Regulated zone 2 and 3 proclamation	4/24/19
Regulated zones 6A and 6B	5 /1/19
Proclamation reducing zone No. 1	Oct. 19

AREAS IN TEXAS AFFECTED BY THE PINK BOLLWORM OF COTTON

Area in regulated zones 2 and 3:		
⅓ of Brazoria County	476 square miles	304,640 acres
Chambers County	648 " "	414,720 "
Galveston County	438 " "	280,320 "
⅓ of Hardin County	281 " "	179,840 "
⅕ of Harris County	352 " "	225,280 "
Jefferson County	1,109 " "	709,760 "
½ of Liberty County	581 " "	371,840 "
Total zones 2 and 3	3,886 " "	2,487,400 "
Area in regulated zones 6A and 6B:		
Reeves County	2,610 square miles	1,670,400 acres
Ward County	858 " "	557,120 "
Total area zones 6A and 6B.	3,468 " "	2,227,520 "
Total area zones 2 and 3.	3,886 " "	2,487,400 "
Total in regulated zones	7,354 " "	4,714,920 "
Area in Robertson County non-cotton zone:		
About	25 square miles or 10,000 acres	
Area in west Texas non-cotton zones:		
Zone No. 4:		
Kinney County	1,269 square miles	812,160 acres
Maverick County	1,332 " "	852,480 "
Val Verde County	3,034 " "	1,941,760 "
Zone No. 5:		
Brewster County	5,006 square miles	3,203,840 acres
Presidio County	2,652 " "	1,697,280 "
Total area in non-cotton zones	13,293 " "	8,517,520 "
Grand total area affected	20,647 " "	13,232,440 "

THE EXTERMINATION OF THE PINK BOLL WORM IN TEXAS

By W. D. HUNTER, *Washington, D. C.*

(Withdrawn for publication elsewhere)

At the conclusion of these papers, First Vice-President Ruggles took the chair.

VICE-PRESIDENT RUGGLES: The time has now arrived for the Presidential Address, which will be delivered by Professor W. C. O'Kane.

THE DAY'S WORK

THE OPPORTUNITY OF THE DAILY CONTACTS IN THE LIFE OF A SCIENTIFIC WORKER

By W. C. O'KANE, *Durham, N. H.*

When a boy has reached the age of six and is ready to enter school we commonly look on that occasion as the momentous beginning of his

education. He is now to begin with books and to acquire knowledge. "You are going to study, now," we say, "and to learn."

"To learn what?"

"Why, to learn many things; spelling and reading, addition and subtraction, all about the different countries and about history, and many other interesting things."

Thus is the great process started and thus it proceeds. As the years pass these matters expand and sub-divide. Arithmetic becomes algebra and geometry, geography grows into political economy. In due time these foundational studies are succeeded by the specialized subjects of college and graduate work. Presently, the round finished, the last laboratory period at an end and the thesis typed and bound, our young man enters his profession and takes up the daily life of a scientific worker. He has completed his equipment.

This accoutrement of formal knowledge is what we usually mean when we mention the training possessed by a graduate ready to undertake a position. Naturally, it is the acquisition that our young man treasures as his principal qualification for the successful pursuit of his calling. Often, in combination with our particular record of experience, it is the measure by which those of us who are no longer beginners take stock of our possibilities in speculations on professional advancement.

Now it would be idle to minimize the value and significance of fundamental and specialized knowledge in the training and equipment of the scientific worker. We all recognize its importance. Nothing else can take its place. Without it there can be no constructive planning of a life of scientific work. It is the string to the bow.

But we shall be foolish if we think of this phase of equipment as the sole or even the major factor that has to do with advancement in a scientific career. It is but one of several. It is indeed one of the hinges on which may swing wide the door to success in life's work. Perhaps it is the top-most hinge. But unless the others that rightly belong there are in place, skillfully made, well-fitted and properly oiled, the door will sag and will never open wide to the full and glorious vision that lies beyond.

The scientific worker, like any other normal person, wishes to succeed in his work. But how shall we define success?

If in our definition we propose to lay hands on concrete and specific terms, no man may define success, except as it applies to him and to him alone—and not even then unless he is more skillful in analysis of his own personality and more deeply aware of the inner meaning of his surroundings than most of us can ever hope to be. For no two men

ever seek the same combination of ultimate ends or propose to arrive at them by precisely the same means.

Yet, we may safely assert that for everyone life is a constant striving toward some goal. No one may escape this effort. It persists through every conscious hour, through every month and every year, so long as life lasts. The particular end for which the individual spends his effort may be noble or base, generous or selfish, physical or mental, fleeting or permanent. It may involve the sweet or the bitter in its attainment. But a striving for it exists always.

We may rightly say, too, that for each individual the day's work holds out some measure of attainment of the object of his effort. This measure may be little or great. Its sum at the end may be tragically small; it may sometimes be unfortunately large. Happily it may be such measure of attainment as to fulfill a well-balanced ideal of a well-rounded life.

Since we do strive, inevitably, and since we do attain, inexorably, may we not define success for the scientist, as for any other thinking being, as a reasonable attainment of worth-while objects of effort.

In reaching this attainment the course of life follows no broad highway. For each individual it is a devious path, winding its way amid constantly varying surroundings, crossing and re-crossing a thousand other paths. He who travels the path must find himself always in varying contact with the physical world about him and with the other human beings who people that world. In his course he must reckon also on the physical, mental and moral makeup that constitute his own person and personality.

It is true of all living things that daily life is a succession of contacts. Its orderly program is a series of adjustments to these contacts and to the conditions and circumstances that they carry with them. For all animals except man the nature of the adjustment is fixed. It involves a problem only in a wide and general sense, not in an individual and specific way. The reaction to a given situation must be speedy, automatic and effective. If it were not, it would not have persisted.

Some such simple arrangement must have prevailed for human beings also in the ages long ago. But with the ability to think and to plan, to alter and control our physical surroundings, and in doing so to unite with others in common effort, there has come to us, as a part of our heritage, a vast and increasing complexity of adjustment. Conditions that were simple have become many-sided problems involving infinite mental and moral checks and balances. Daily life, which was once a well-charted course, has become an intricate study.

In speaking of adjustment the word must not be misconstrued. It

implies recognition of circumstance, but it ought never mean surrender or subservience. The history of mankind is too crowded with the records of victory over difficulty to recognize any doctrine of retreat. Hueber, a scientist with sightless eyes, Beethoven, a great composer living in a soundless world—these and a multitude of others deny the existence of defeat.

In this problem the scientific worker today shares in marked degree. If, for a moment, we may place ourselves at a distance from the typical day's work of the scientist, in order that we may compare it with the round of duties of other men, we shall find that it is not set to a certain program as is that of a great number of people about us. For others the routine of the day is fixed. The procedure to follow is settled. The job is standardized. Nothing of that sort is or should be true of the scientific worker. His very freedom itself complicates his task. The manner of his work he may alter if he desires. Furthermore, his life is lived in a world within a world. He has a double adjustment to make because of contact with fellow workers in faculty or department and a quite different contact with the remaining people of his community. The very subject matter that constitutes the basis of his life's task is in a constant state of change and growth. Steel is not steel in his day's task; wood is not wood. The material he works with today has changed by tomorrow. Because he is earning his living with his brains he is apt to forget about his body. A multitude of his daily adjustments must be intangible. Their properties and bounds may not be held up before the eye but are invisible, fleeting. Yet, just for these reasons it is vital that the scientist should be making these adjustments with skill, understanding and foresight. They are worth his study.

With few exceptions scientific workers are employees of some institution or bureau whose function it is to bring together men in the same or related lines of work. Our daily associates, therefore, are for the most part men who are engaged in work similar to our own. Their aspirations are brother to ours. Their gifts and failings are our own. Whatever tendency to prejudice girdles them about pulls equally at us. The circumstance that gets on their nerves gets on ours. And so, too close contact of like substances occasionally sets up friction, in the heat of which some of our best possibilities are apt to boil away in useless vapor.

Now it is obvious that we all desire the buoyant help that comes from the well-founded admiration and respect of our associates. There is no stronger incentive to good work than that. We crave and need the well-earned approval, confidence and liking of our co-workers.

Yet it is a law of human contact, long since proved by experience and deeply rooted in the makeup of all of us, that we get from our neighbors what we give to them. Think of them as what they are—able men and women doing good work—and they will soon think of us in the same way. Realize that they are living out their lives in their own way, as is their right, and that our failure to see their good work is due to the glasses that we have placed before our eyes. It would not be well that all kinds of human excellence should be alike.

"Men," said Dr. Holmes in *The Autocrat*, "often remind me of pears in their way of coming to maturity. Some are ripe at twenty. Some come into their perfect condition late. And some, that have been hard and uninviting until all the rest have had their season, get their glow and perfume long after the frost and snow have done their worst with the orchards. Beware of rash criticisms; the rough and astringent fruit you condemn may be an autumn or a winter pear. . . . "

In the relation between ourselves as members of a staff and the officers of administration to whom we are responsible there should exist a thorough understanding, carefully and thoughtfully maintained. On our part, as employees, it will be helpful to remember that in the various problems that arise involving adjustment between ourselves and administrative needs we are quite likely not to know the whole facts of the case. If we knew them probably our views of the matter would be altered. It is a very human and very universal failing to form opinions on insufficient data. We all do it. Most of us have had the experience of discovering, at a late date in a discussion, facts that we did not suspect and that, once known, altered our judgment. We cannot see all around from a position down below. The point of view from which complete vision is available is at the top.

Turning the question the other way about, if we ourselves have administrative functions we shall strengthen the efforts of our associates and assistants if we will bear in mind the clarifying effect of complete information. Men cannot read one another's thoughts. And since they must come into intimate contact and must base their acts, in ever-increasing degree, on the plans and purposes of others, a frank discussion beforehand is a worth-while help and safeguard.

In this same direction it is to be hoped that the process of organizing going on within our various bureaus and institutions may not proceed to the point where forms and formalism displace personal contact and understanding. The thing seems to be like some plant that has escaped from cultivation: a useful species to indicate a border or a path but a nuisance and an obstruction when it gets out of bounds. One is reminded of the words of Mr. Britling, where he says, "All organization, with its implication of finality, is death. Organized morals

or organized religion or organized thought are dead morals and dead religion and dead thought. .Yet some organization you must have. Organization is like killing cattle; if you don't kill some the herd is just waste. But you mustn't kill all or you kill the herd."

For most scientific workers it must appear that the ordinary day is filled with a multitude of minor duties. Routine of some sort absorbs an extraordinary proportion of our time. In the midst of this it is difficult to see how we may find opportunity for thoughtful and constructive adjustment. This round of routine is apt to grow more extensive and exacting as the scientist advances in professional rank

In the midst of this distraction it is well to realize that any man, in any pursuit whatever, finds a multitude of details that must be done in order to carry forward his work. Even in purely creative work, in writing or painting, there is a necessary routine that will astonish one who has not observed such work in the making. Doubtless it would impress us as drudgery to spend weeks in study of a set of blank walls, yet that was a part of the process by which Michelangelo executed his great frescoes. We are charmed by the beauty and vivid detail in the novels of Scott, but we find that he spent many days in intimate study of the topography, botany and geology of a locality before he used it as the setting for one of his incomparable scenes.

All of these details were necessary means to an end. In no other way could that end be achieved. And because they were necessary they were a part of that end. They helped to bring about the consummation of an ideal. In so doing they, themselves, became a part of that ideal in just the same essential degree that the foundations of a building, deep beneath the ground, are an essential part of the final structure.

So, in the routine of our work as scientists, details have their part in building toward an ultimate ideal. Without the interest of that ideal they are so many bricks and so much mortar, heavy to handle, dreary to contemplate and devoid of any attractions. But from these materials we may, if we will, build structures whose service and beauty are limited only by our capacity and enthusiasm.

A purpose, then, is the alchemist which can transform a day's drudgery into a day's progress. If it should be that interest itself is fundamentally lacking for any of us, then there must be a misfit somewhere and if there is a misfit there must be a change. A change may be of two sorts. In rare instances the circumstances may be such that a change of occupation is really the only way out of a difficulty. But usually it is not that which is needed. It is a subjective question rather than an objective. The alteration required is in our own viewpoint rather than the thing viewed.

It is a happy truth of psychology that interest tends strongly to follow close on the heels of purposeful work. Throw your energy into a task and the task itself speedily acquires a surprising interest. Assume the attitude of enthusiasm and presently enthusiasm follows. But sit down and look askance at a duty, thinking what a dreary round it is, and interest will shy away beyond reach or ken. Contemplate the job long enough in this fashion and by and by the job itself will become impossible.

It is a further reassuring law of psychology that wherever interest exists there will be found some measure of innate ability. If we find that we can instill interest into the day's routine we may be sure, also, that there lies within us the power to build out of that routine an attainment worth while. In so doing we shall inevitably find pleasure in the work. For there is no other pleasure possible to a human being that can equal the satisfaction of carrying through a worth-while task to successful conclusion.

If, as we contemplate our ordinary daily routine, it appears that much of it fails to lead us anywhere, may we not look on that fact itself as a problem of surpassing interest. When we have given it study as such, we shall certainly find a way to improve conditions. In so far as we may exercise a choice it will be worth our while to single out for more sustained effort the parts of our day's work that are permanent and worth while. Many of us must have been surprised to discover at times that under necessity we could carry through an effective day's work in a half day's time. It would be foolish to attempt this at the expense of needed recreation, rest, and study. Nevertheless, there is something of suggestion in the experience. Success in life is not so much a matter of exceptional brains as a question of the habitual daily program.

A human being is fortunate that has the privilege of following out some line of investigation as a part of his normal duties. A scientific problem is to the mind precisely what physical exercise is to the body: both an incentive to effort and a means of increasing the power for such effort. Granted that we have opportunity for investigational study—and all of us should have it in some fashion or other—we may rightly expect from these duties the increased mental efficiency that is certain to follow their performance. A scientific worker, if his daily task is well conducted, must learn how to think.

Now thinking is not a continuous process in the human race—including ourselves. A very great part of our activities are automatic. We arise in the morning, dress, eat breakfast, look through a morning newspaper, ride to the office, open our mail. Friends or associates arrive and we converse with them on various topics. We hear classes, mark

papers, sign reports. Presently it is evening and the day is done. In the course of this we have, occasionally, done some real thinking. But it has not been so continuous or so deep as to strain our mental faculties.

The scientist, in the investigational phase of his day's work, must learn to do better than this if he is to stand in good repute. The road by which he may surely arrive at scientific truth bears little resemblance to the sketchy path ordinarily followed in reaching conclusions, even his own, outside of science. People in general do not actually think out statements of fact. Select ten newspapers. Toss a statement through them to ten hundred thousand readers. It will be gulped down promptly and completely, like so much breakfast food. We all do it. Start a rumor and you can watch it grow into fact before your astonished eyes. Not all people impose thus on themselves all of the time, but some of them do it all of the time and all of us do it some of the time. If, in addition, the supposed facts are fed on sentiment their health and strength are doubly assured. Falsehoods swallowed as facts are causing acute indigestion in the labor world today. In the words of Josh Billings, "Tain't what men don't know that makes trouble in the world; it's what they know for sartan that ain't so."

Even experience seldom furnishes complete and reliable data. It may readily afford isolated facts but the causes of those facts may remain totally obscure or completely misinterpreted. The observations that make up experience usually lack the precision that is a necessity in genuine scientific work. They are not planned to secure continuity. They are not marked by that freedom from personal bias which is essential in a clear-cut search for truth. The observer has seldom the foundation of apperceptive data in the light of which alone can findings be properly weighed and measured. On the contrary, related facts are likely to be faulty. A king of England, a good enough king, once asked the Royal Society to investigate the reason why, when you place a live fish in a bucket of water, you do not thereby increase the weight of the vessel of water. The members of the society replied by correcting the fact.

All of which serves to point out the mental stimulation that is a happy by-product of investigational studies. Real thinking may be somewhat unusual, but it is quite an available process, in the exercise of which one's mind is inevitably quickened. The methods of research are good standards to carry over into other phases of daily life.

Consciously or unconsciously we follow a rather definite procedure in every piece of genuine investigational study. It begins with the stimulus of an unsolved problem. Thence it proceeds through successive orderly steps which include the isolation of a specific question

for study, the collecting of experimental data, the formulation of hypotheses, the trial of these while withholding judgment and finally the proposal of a conclusion which we have found to stand trial and test. There is much of interest and suggestion in these steps.

The stage by which we recognize the existence of a problem is presumably automatic. It is automatic because there are so many unanswered questions to perplex daily life. Some of these are bound to press upon our consciousness, clamoring for solution. We are not aware of all of them for the reason that we have grown accustomed to accepting many things as they are.

Out of the multitude we select a specific question to which our energies shall be devoted. This essential preliminary step is not always easily accomplished. Various questions are complexly interrelated. We must unravel some of these intricacies. We must pare our subject here and there, in order to reduce it to usable size.

Then begins the step of collecting data. We are now to set ourselves patiently to observe facts and to record them. But that is not all. The facts must constantly be observed in the light of their possible relationship, for the ultimate object of our inquiry is a matter of causes and, therefore, of principles and laws. Mentally, we have in this a somewhat delicate balance to maintain, for we must be painstakingly accurate yet must not become wrapped up in detail to the exclusion of wider truths, we must demand that which is concrete and specific while searching for that which is abstract and generic, we must be skeptical yet possessed of an open mind. Neucomen was searching for truth and demanding fact as he went about his study of the steam engine. But his open mind flashed to him an interpretation when his apparatus performed in unexpected manner, and the result was the principle of condensation by means of a jet.

In the light of our accumulated data we propose our tentative theories and in this we shall need all that we possess of constructive, resourceful imagination. Sometimes we speak of imagination as if it were a handicap to a scientific worker, a faculty to be sternly repressed and stifled. There could be no greater error. A well-ordered power of conjecture is a precious attribute. Observation alone is not sufficient. Facts by themselves do not disclose relationships. All of the observable facts in the world, unillumined by imagination, would never have disclosed the causes of insect fluctuations, the laws of the procession of the planets or the possibility of liquid hydrogen. Only when winged by conjecture, can the mind cross the void from fact to relationship. "The imagination," said President Eliot, "is the greatest of human powers, no matter in what field it works—in art or literature, in mechanical invention, in science, government, commerce or religion;

and the training of the imagination is, therefore, far the most important part of education. . . . Constructive imagination is the great power of the poet, as well as of the artist, and the nineteenth century has convinced us that it is also the great power of the man of science, the investigator, and the natural philosopher."

While the process of accumulating data is proceeding it is helpful to stop sometimes with the deliberate intent of withdrawing a sufficient distance from the object of inquiry to see it in perspective and to discover if its newly-ground facets may not catch some light from its surroundings. In the laboratory notes of Faraday are these words: "Nothing is too wonderful to be true if it be consistent with the laws of nature. Let us encourage ourselves by a little more imagination prior to experiment. Let the imagination go, guarding it by judgment and principle, holding it in and directing it by experiment."

And finally, in the course of investigation, we find ourselves practising that rarest of mental acts, suspension of judgment while our theories are standing the trial of deliberate test. It is a fine training. Men do not usually withhold their opinions in that fashion. Suspense is unpleasant to the human makeup. Continue the suspense long enough and there is relief in the drawing of a conclusion however hasty and ill-considered. Wrap the mental makeup in the mantle of likes and dislikes, prejudice, desire or habit, and deliberately suspended judgment becomes rare, indeed. To practice it is good discipline.

And so, in following out these processes in the course of his daily work, the scientist may rightly feel the satisfaction that comes from doing worth-while things in a worth-while way and may readily find for himself the interest that goes with a program of exploration and adventure. There is no visible limit to the field. For every truth that was dug out of the darkness in the course of the nineteenth century, a hundred have seen the light in the twentieth. No one has ever reached the horizon of scientific work. As new rooms are added to the great edifice of science there are new, dim corners to be explored.

Nor may we assume that all that we commonly accept now is necessarily true. Acceptance is not finality, even in the face of abundant proof. The earth was known to be the center of the universe until Gallileo and Copernicus discovered otherwise. Not many generations have elapsed since a professor in Harvard University proved that to telegraph to Europe beneath the ocean was impossible.

In the classroom duties that fall to the lot of many of us there are extremes of contrast. The work may be made a dreary routine of boredom or it may be enlivening, interesting, inspiring. You will readily find examples of each.

The teacher is a good deal like a gardener. There are plants of various characteristics filling the garden. Individually, they are what they are, so far as species is concerned. The gardener cannot change that. He cannot bring them plant food to be injected into them and thereby change their makeup. But he can shape their growth and can profoundly influence their final form and utility. In accomplishing this he must hoe and rake and lug water. If he thinks of these tasks as sheer, purposeless routine, his garden will suffer and he, himself, will lead a dreary existence. If he considers his plants as living things, whose possibilities he will deeply influence, his daily task is illumined and refreshed.

Why are students taking the courses that we offer in college? What are the purposes of college training? It may not be amiss to consider them, for they are not always clear in the dim light that sometimes pervades college classrooms.

Undeniably one of the purposes of any college course is to increase the students' store of usable facts. From much of the curriculum we might infer that this is the only important purpose in going to college. It is not so. But, frankly, it is a real purpose, an honest one. It is not so much a case of storing facts that shall in after years be promptly recalled on request, like so many cartridges stored in a mental magazine, each ready to go off on demand. The wider and deeper aim is to increase the range of acquaintance of the mind, to give it a subconscious foundation for a purposeful structure that is to come later. Facts form a necessary apperceptive basis. They are bridges leading in many directions. They furnish for the living room of the mind a sort of indirect lighting that illuminates shadows and enables future work to go forward smoothly. So the storing up of facts is a proper purpose.

But facts are interesting in their relationships. They lead by induction to principles. Whereas facts are limited and exclusive, laws and principles are limitless and inclusive. Facts are the minute pieces of a mosaic. Principles are the pattern. A knowledge, then, of principles and laws is a further purpose of college training.

These things, facts and principles, are external. But it is the purpose of a college education to train the student to think for himself; to make his own observation of facts; to draw his own safe and sound conclusions. In the words of Coleridge, "to educate is to train to think, for by active thinking alone is knowledge attained." In the exercise of this function the student is to construct his life's program of activity. And so it is a third function of college training to help the student to realize his best possibilities in his life work.

Yet, even this is not the summit of college aims. We should be doing

our task poorly and incompletely if we thought only of facts and laws and their utilization in efficient mental process. A college has failed unless it has given to its young men and women a wider vision of life itself, has pushed back the horizon, has served to give new meaning and value to the things which make up life. "The purpose of education," said Spencer, "is to prepare for complete living."

The method, the technique, by which the instructor may best seek to further these purposes has never been well studied and defined in the realm of college teaching. There is no comprehensive fund of recorded experience on which we may draw. In meetings of college faculties our time seems rather to be occupied with discussion of proposed new courses, re-arrangement of those that exist and discourse concerning student absences, grades and petitions. There appears to be a sort of general theory that a college student is mature and fixed in his mental processes. It seems to be sufficient if the instructor enunciate a multitude of facts. And, in truth, probably the instructor is doing as he was done by.

But the psychology of learning does not cease with the grammar grades. Indeed, in the great fundamentals, there is probably little difference between the learning processes of the high school student and those of the college student. In the secondary schools the question of teaching methods has received much study. There is no reason to confine to the high school many of the principles now recognized and accepted. Read again that lucid volume by William James entitled "Talks to Teachers," and consider if the suggestions there made do not apply to all teaching.

In our college classes, as in the grades, we shall do well if we take pains to lead our students from the familiar to the unfamiliar and not plump them into the wholly new without anchor or compass. The store of experience and knowledge that a student already possesses is his only possible basis for understanding and interpreting new facts. The bridge from the unknown to the known cannot span great gulfs at a single leap, but must arch from pier to pier. The new thing that has a discernible relation to something already familiar is armed at the outset with interest.

Again it will best avail our purposes if we constantly let the simple precede the complex, the concrete precede the abstract. To proceed from principle to example, even though the principle may be expressed in few words and the example require many, is to run contrary to the normal process of the human brain. A law is simple to us as teachers because we have had experience with many illustrations of it, but to the student who lacks this apperceptive data the law is complex.

We need not be ashamed of constant and constructive effort to

arouse and maintain interest in our classes. "Interest," said Joseph Cook, "is the mother of attention, and attention the mother of memory; if you would secure memory you must first catch the mother and the grandmother." If we would be certain of intelligent interest from the beginning we must make sure that the bearing of our particular study on college training in general is understood by our students. Certainly there is a reason why we propose to ask their time and attention. If there is none we'd better do something else. But the real relation of that particular study to the student's equipment may be quite obscure and its bearing once revealed may be an agreeable surprise.

Throughout all of our contacts in teaching we shall greatly help ourselves and our work if we thoughtfully cultivate a sympathetic understanding of the student's point of view. It is not the same as ours. The scale by which he measures the importance of life's events is different from ours. In any life such a scale is constantly changing. Our own has materially altered and will keep on changing so long as we live. We are apt to forget that and thereby to misjudge a student's exuberant interest in fraternities, sports and kindred affairs. Those things are his own. They are absorbingly interesting. If we permit our classes to be dull can we wholly blame him for his choice?

In any of the contacts into which the winding path of the day's work may lead us, we, ourselves, form half of the bargain. Adjustment then must always be as much concerned with the person that travels the path as with the path itself and its other travelers.

In this purely subjective side there can be no doubt as to what factor ranks first. A good many years ago a man named Paul, in a letter to the people of Corinth, spoke reverently but sternly of the human body as a temple. For thousands of years before that and through every year since, the admonition has been constantly repeated. It must be confessed that we need it.

The fact that we as scientists are engaged in work of a mental character may make the way easy to imperfect health, but it in no wise makes that physical state allowable. On the contrary, because of its mental product, our machinery for the day's work is the more easily rendered inefficient. No mental process takes place without a corresponding physiological output. We drive our team of body and mind with a single pair of reins. As we direct the one, so goes the other.

In speaking of health we mean today more than freedom from obvious bodily impairment. There is a state of health much higher than that, a physical trim, a complete well-being in which one's poise is perfect and alert, one's energy instantly ready, one's reserve full

and complete. Such physical fitness promptly carries over into the mental world. It clarifies judgment. It eliminates boredom from routine. It establishes confidence. It carries its possessor forward to an undreamed-of realization of his own possibilities. It makes us pleasanter people to live with.

Few of us possess real physical fitness. Of the thousands of men who have been examined by the Life Extension Institute,—most of them men of exceptional intelligence and training,—an astonishing percentage are found to be physically impaired. Usually these men did not know of their impairment or that they could readily, in most cases, attain a degree of health and efficiency hitherto unguessed.

It has been easy to slip into ways that reduce physical vigor in these modern days of highly organized mental and economic life. The grandfathers of most of us had to be physically active. On the whole they probably lived a more normal physical existence than most of us enjoy. There is no essential harm in present-day strenuous living if we order it thoughtfully. But we must think about it. We can avoid subjecting ourselves to senseless hurry, to unnecessary eye strain, to ill-considered diet, to worries carried home. We can work, play and sleep in the rejuvenating oxidation of fresh air.

None of us ought to permit himself to finish the day's work with reserve energy materially depleted. Fatigue is not local. When any part of us grows tired our blood stream carries the poison to other parts of our body; we cannot overwork one part without feeling the ill effects elsewhere. It is helpful to remember this, because physiologists have come to have a new conception of the importance of brief and frequent relaxation as a means of maintaining one's store of reserve energy. We shall work better if we deliberately seek it.

We need occasional long vacations. There is no other way in which to get a renewed and freshened outlook on our work and to clarify our appreciation of life's values. Keeping one's nose to the grindstone is neither the proper place for the nose nor a suitable occupation for the grindstone. "There is nothing," said Stevenson, "so much a man's business as his amusements." If we stay close to our work long enough and steadily enough, we come to believe, after a time, that the work would collapse without our help. Eminent statesmen in our own recollection have illustrated this phenomenon. We get into a habit of daily routine which unconsciously we dislike to break. We need the change but we shy from it. There is no surer proof that a new set of surroundings and a new viewpoint will be wholesome for us.

Even without waiting for a vacation period we may find great help in restoring to our daily round something of the physical activity that

our ancestry proves that we need. Walking twice a day two or three blocks to one's office is not following a system of physical exercise. Walking five or ten miles is getting nearer to it. Whatever the form of exercise there must be interest in it. Forget the elements of your profession. Study the stars. Observe the rocks. Carry a camera with you. Train your lens on flowers, trees, birds, landscapes. Let it help your eye and mind to a new viewpoint and your body to new vigor and well-being.

If that which we choose for our diversion is well selected, if we follow it consistently, we shall be certain to find that our interest in it widens and deepens. Before long we shall have that excellent adjunct to the day's work of the scientific man—a hobby. Any man is the better for the possession of a judicious hobby. We, who are living in the circumscribed scientific world, are no exception to the rule. Through it we shall daily freshen the flavor of our routine work; we shall the better understand the bearing of our profession on the affairs of the world at large and the right relation of ourselves to the workers in the wider world.

This, like many other phases of the day's work, is a question of deliberately organized habit. We used to think of habits as largely a matter for lifted eyebrows, the facetious subject for New Year's resolutions. They may be that. But they may, also, be one of the most useful and satisfactory attributes of living. They are not necessarily dogged, senseless, fortuitous affairs. We may build them largely to suit ourselves. It is one of the pleasant things about psychology that it has taught us how to transmute our routine of physical life into a program of mental and spiritual growth. Even the posture that we school our body to assume presently finds its reflection in our mental attitude. The erectness of body, the level carriage of head, the vigor of muscular tone, the sturdiness of strength, the poise of coordinated muscles, all of these we may deliberately seek, and in the finding we shall renew our inmost character.

By this means we may choose what we shall be. True we shall never attain to all that we choose. It would not be well for us that we should, for life is quest as well as attainment and its fullest measure is realized in a reasonable mixture of the two ingredients. We shall not even have before us an unvarying, specific ideal, for that toward which we strive does not assume such definite form. Its outlines are always indistinct and always changing. But its substance we may picture in our mind and heart and as we contemplate that picture, so we shall grow toward it.

Through it all there is ever this truth: that to the scientist is granted the great privilege of a life of service to his fellow men. In the con-

sciousness of this privilege, realized little by little in the course of the day's work, there can come abiding joy.

Vice-President Ruggles: Is it your pleasure to discuss the address at this time?

Mr. C. L. Marlatt: I have been very much pleased in listening to this discourse. I think we all have been interested in the philosophical discussion of a broad subject. I think the greatest compliment to Professor O'Kane is to accept this address as a thoughtful, well-rounded subject, of interest to all of us and helpful to all of us. In lieu of discussion, if I have sensed the situation, I should be glad to move a vote of thanks and appreciation to the President for the Address.

Mr. P. J. Parrott: I rise to second the motion. I feel like repeating what Mr. Marlatt has just said. We have listened to this address with a great deal of pleasure. It is one which I think will prove profitable because of its common sense and its idealism. It has left us little to elaborate upon.

The motion was unanimously carried.

Vice-President Ruggles: The next paper on the program is "The European Corn Borer Problem," by Dr. E. P. Felt.

THE EUROPEAN CORN BORER PROBLEM

By E. P. Felt, *State Entomologist, Albany, N. Y.*

Although the moths were reared in 1916, the insect was not recognized as a pest and carefully studied until the following summer. The investigations were continued in 1918, and the results are given in detail in the Massachusetts Bulletin (1).

Spread

A moderate extension of the infested territory was noted in 1918 and was followed in 1919 by the discovery of two widely separated infestations in New York state and an apparently very great increase in the infested area of Massachusetts, the latter extending from Cape Cod into southeastern New Hampshire. The known spread of the insect is summarized in the following statement:

Area Infested

December, 1917	
Massachusetts	100 square miles
December, 1918	
Massachusetts	320 square miles

December, 1919

Massachusetts	1900 square miles
New Hampshire	20 square miles
New York	
Schenectady area	500 square miles
Western area	400 square miles

Too much emphasis should not be placed upon the apparently very great extension the past season owing to the fact that the insect was certainly present in New York areas in 1918, and very probably at least a year or two earlier. There are some who believe the borer may have been in most of these areas for nine years or thereabouts. We would prefer additional data before accepting such an estimate without reservations.

It was believed at first that the European corn borer was brought into this country with hemp imported for the use of rope walks near Boston, though there is a possibility that it may have been introduced with broom corn and in this connection it is interesting to note that there is a broom factory at Everett, Mass., an extensive broom industry at Amsterdam, N. Y., and at least one small broom factory at Irving, Chautauqua County, N. Y. It should be noted that the New York infestations have excellent rail connections with the older infested territory north of Boston. Since the European corn borer may be carried in the larval stage in the stems of a considerable variety of plants, these outlying infestations and in fact the presumably original one near Boston may have originated through the shipment of any one of a number of infested plants. It has even been suggested that green house plants may have been the original carrier, though hemp and broom corn are presumably the more probable mediums of transportation. It is a little remarkable that all infested places at the somewhat distant points are directly west and none southwest of Boston. The infestations directly south of Boston were probably brought about by the shipment of green corn to summer hotels.

Conferences and Hearings

1918

September 6, conference at Boston, Mass., attended by a number of entomologists and agriculturists from the northeastern United States, together with representatives of the Federal Bureau of Entomology.

1919

February 7, conference at Albany, N. Y., attended by representatives of the New York state commission of agriculture, official

entomologists of New York and representatives of the Federal Bureau of Entomology.

February 12, hearing at Washington before the Senate Committee on Agriculture, attended by entomologists and agriculturists from Massachusetts and New York and representatives of the Federal Bureau of Entomology.

February 13, hearing at Ithaca, N. Y., held by the Council of the Department of Farms and Markets and attended by representative agriculturists and entomologists of New York state.

August 28, 29, conference and field survey at Albany and Boston, respectively, attended by a number of commissioners of agriculture and entomologists mostly from the middle and eastern states.

October 3, 4, field survey by representatives of the Federal Horticultural Board, agriculturists of Indiana and the state entomologist of New York at Boston and Schenectady respectively.

October 8, hearing at Washington before a subcommittee of the Senate Finance Committee, attended by commissioners of agriculture and entomologists mostly from the middle and eastern states.

In addition the Federal Horticultural Board has held three hearings, and one conference in the past two years and the problem has been discussed at various meetings, among which may be mentioned our last annual meeting at Baltimore and the recent meeting of the National Association of Commissioners and Departments of Agriculture, held at Chicago, November 12.

Publicity and Important Publications, 1919

1. Caffrey, D. J., The European Corn Borer Problem. Econ. Ent. Journ. 12: 92–98.
2. The European Corn Borer, U. S. Dept. Ag., Bu. of Ent., in Coöp. with Ext. Serv. St. Agr. Coll. (poster).
3. Felt, E. P. Cornell Extension Bul. 31, pp. 35–42.
4. The European Corn Borer. Dept. Farms and Markets, Div. Agr. Circ. 182.
5. Vinal, S. C., and Caffrey, D J., The European Corn Borer and Its Control. Mass. Agr. Expt. Sta. Bul. 189, pp. 1–71.
6. Caffrey, D. J., The European Corn Borer, A Menace to the Country's Corn Crop. U. S. Dept. Agr. Farmers Bul. 1046, pp. 1–28.
7. Felt, E. P., European Corn Borer. Univ. St. of N. Y., School Bul. Je. 1 (poster).
8. Proceedings of the Conference on the European Corn Borer held by the National Association of Commissioners of Agriculture, with state entomologists and representatives of the United States Department of Agriculture. Dept. Farms and Markets (N. Y.), Div. Ag. Bul. 123, pp. 1–74.
9. Woodbury, C. G., European Corn Borer Investigations. Congress. Record, Nov. 4, pp. 8409–8411.
10. Marlatt, C. L., European Corn Borer. Rept. Fed. Hort. Bd., Oct. 1, 1919, pp. 8–13.

The federal poster (2) was widely and generally distributed in areas where there appeared to be a reasonable possibility of the borer being present. This was particularly true of New York state after the discovery of the Scotia infestation. The New York poster (7) was generally distributed to the schools of the state and in addition, popular articles were prepared, sent to practically every local newspaper and published by a very considerable proportion of them. Cornell Extension Bulletin 31 (3) was generally distributed throughout the state of New York, an edition of 40,000 being printed. The United States Farmers' Bulletin (6) was generally distributed throughout the country, specially in the northeastern United States. It is worthy of note in this connection that while the initial discovery of the two infestations in New York state were brought to light through publicity, the extension and subsequent delimitation of these areas was due in considerable measure to systematic scouting.

There are serious limitations upon publicity so far as such an insect as the European corn borer is concerned and yet it is believed efforts along this line have amply justified themselves. The experience of the past year is a very strong argument in favor of systematic, well directed scouting as an adjunct to publicity. Neither should be used to the exclusion of the other.

In addition to the official publications listed above, a few specially interested states and Canada have published short bulletins or leaflets on this pest and there have been numerous popular accounts appearing in the agricultural press in particular. It is noteworthy in this connection that Mr. Allen's article in the *Country Gentleman* of January, 1919, was responsible for bringing the Scotia, N. Y., infestation to the attention of the Cornell entomologists.

Scouting

The scouting of the last few months has been done mostly by agents of the federal government and the limitations in connection with the work emphasize the difficulty (10, p. 9) of quickly ascertaining the precise extent of the infested area. The approximate size of the New York areas appears to have been determined and it would seem that if the insect had become established in any numbers in other sections of the country it would have been brought to notice before this.

Quarantine

The Federal Horticultural Board promulgated Quarantine No. 36, effective October 1, 1918, and the states of Massachusetts and New York have also laid quarantines, modifying them as developments warranted. These quarantines were all limited to corn on the ear and

cornstalks. The state of Florida has laid a most sweeping embargo upon the shipment of plants or parts of plants from the infested area, while the Canadian government, by order of council, has prohibited the shipment into the Dominion of corn fodder or cornstalks from the infested area.

The extension of Quarantine 36 to include the entire infested area has been seriously considered by the Federal Horticultural Board and owing to the uncertainties of the situation it has not, due in part at least to the difficulties in ascertaining the limits of the infested areas, been put in force.

Economic Status

There have been, during the last few months some statements voiced (9, 10) tending to indicate that the European corn borer may not prove to be an insect of much economic importance. These opinions appear to be based upon the fact that there was considerably less injury in the infested area in Massachusetts in 1919 than was true of some of the badly infested fields in 1918. Apparently little allowance has been made for the possible beneficial results following a general, though perhaps not entirely effective clean-up, for the activity of ephemeral and unreliable parasites, for the fact that seasonal differences may have been very unfavorable to the borer, and the obvious variations in the infested area.

A general clean-up, even if a somewhat indifferent one, would result in the destruction of millions of borers and of itself should considerably lessen injury from the second brood. A well known, minute egg parasite, notably extremely variable in abundance from season to season, severely checked the borer. The development of the second brood injury in eastern Massachusetts was nearly a month later[1] in 1919.

[1] It may be significant that both the Blue Hill (mean 68 4°, departure from normal +1°) and the Concord (mean 68.3°, departure from normal 0°) Massachusetts records show a normal or a little higher than normal monthly mean temperatures for these stations in August, 1918, and decidedly subnormal records (mean 64.5°, departure from normal −2.9° and mean 65°, departure from normal −3.3° respectively) for the same month in 1919, a period of practically continuous development and growth for the second brood. Taking 43° F. as the critical temperature (it is probably higher for this season of the year) Blue Hills would have effective temperatures for August, 1918, amounting to 787.4, an increase of approximately 4 per cent above the normal and for August, 1919, effective temperatures of 666.5, a decrease below the normal of nearly 12 per cent, the total range between the two seasons for that month amounting to nearly 16 per cent of the normal effective temperatures. The Concord records show a normal (mean 68.3°, effective temperatures 784.3) for August, 1918, and a marked decrease (mean 65°, departure from normal −3.3°, effective temperatures 682) in 1919, amounting to more than 13 per cent of the effective temperatures. These figures justify expecting a retarded development, which latter was substantiated by field observations.

Thus, a combination, rarely to be expected, greatly mitigated the damage of 1919. It is hoped that such conditions will prove more frequent in the future. It is one thing to note a deficiency of this character and quite a different matter to allow such variations to materially influence a policy which may have far-reaching effects. It is impractical to apply the general code of the criminal law and hold an insect incapable of harm until it has proved its ability to cause serious damage over wide areas year after year, because such demonstration would very probably make it impossible to economically check or control the pest.

Considerable stress (8 p. 66, 9 p. 8410) has been laid upon the practical immunity in certain small plots at Medford, Mass., of a rank growing southern corn and this has been used to support the hope that dent corns of the south would escape serious injury. The damage in none of these plots was serious and in view of the decided tendency of the moths to select early varieties for the deposition of eggs, a habit most evident in New York state, we hold it to be unsafe to rely to any material extent upon such a slight and comparatively unreliable indication.

The occurrence of but one brood with consequent limitation of injury in the infested areas in New York state is conclusive evidence of the effect a relatively slight change in climate may have upon this insect. Of itself, it justifies a pessimistic attitude toward the reduction in injury in eastern Massachusetts in 1919, and at the same time affords no substantial basis for any such relative immunity for the larger portion of the corn belt. There is every reason for expecting two and in the more southern portion of the country three broods or generations each season. The prolonged period of activity might be expected to offset in large measure, at least, any advantage accruing to a rank, rapid growing variety of corn.

The possibilities of clean culture or modifications in agricultural methods, likewise appear to be overstressed (9 p. 8410) when it is remembered that these conclusions are based upon examinations of comparatively few fields and that even in the older infested areas in Massachusetts there is considerable local variation in the degree of infestation, a condition much more marked in New York state. This is no argument against the utilization of such methods to the utmost. It is simply a warning against depending upon them to any great extent until their utility has been demonstrated.

There should be due conservatism in the estimation of probable injury and the same is equally true, if not more important in regard to approximating probable immunity.

Whether we wish to do so or not, we must shortly make a decision as to the economic status of the European corn borer. If we admit that it has serious potentialities and is capable of causing even a 10 per cent loss to the crop, we still have an insect of the first magnitude, worthy of most careful investigation and justifying the utilization of every reasonable measure to prevent spread and promote the control of the pest. Should it be decided, however, that this insect is of slight importance and is destined to have little effect upon the corn crop of the country, then we are compelled to hold that a moderate amount of knowledge concerning the insect is all that is necessary, that there is little justification for exhaustive investigations and that large scale control operations are indefensible.

If the first be true, states vitally concerned and the federal government should make liberal appropriations for the further investigation and control of this insect. Otherwise, as professional entomologists, guardians of the public welfare, we should oppose all efforts to secure money for any such purpose.

Problems Affecting Control Work

The Bureau of Entomology last August proposed first of all to determine the present distribution of the insect as a basis for a quarantine and other control measures. There are practical difficulties (10, p. 9) in following this plan and if there is to be effective control it will be necessary, in our opinion, to push more than one line of activity or else serious efforts to control the pest should be abandoned. The experience of the past season discloses some habits which emphasize the difficulties of handling the situation. The insect breeds in a considerable number of plants, over fifty, and has been found in the stems of quite a number of others. It is very probable that the borer multiplies freely upon relatively few plants and that practically speaking we can ignore its presence in many. We may have with this pest a duplication in some respects of our experience with gypsy moth food plants. There is need of more information concerning methods of spread, though work in Massachusetts the past season shows that individual females may make a single flight of as much as 287 yards and that marked individuals were recovered at a distance of 600 yards. Females may live 33 days, the eggs being deposited in small masses during a considerable portion of this period. The maximum egg production from one individual was 1,192. The occurrence of the borers in underground stems and their occasional presence in farm crops such as oats, greatly complicates the problem of control.

The apparent possibilities justify serious questions as to the feasibility of control. This latter can be determined only by field

operations on a comprehensive scale and in view of the destructive potentialities of the borer such an undertaking is favored.

Secondary Conditions Affecting the Problem

The control of the European corn borer is by no means a simple problem in entomology or a question of organization. The infestation of three and possibly four states vitally concerns as many different sets of officials as well as representatives of the federal government and all in turn are dependent upon law making bodies for the necessary appropriations. It is entirely possible for one group or even a portion of a group to largely prevent effective work and by the very nature of the case there is such an excellent opportunity to evade responsibility, that at times it is almost impossible to ascertain the real cause of unsuccessful coöperation or activity.

These statements simply describe the situation as it exists and justify a question as to the desirability and possibility of evolving more effective ways of handling limited infestations of destructive insects. It is a condition not peculiar to entomology or even to science. It is something found in many lines of governmental activity.

Destructive insects have been introduced into this country in earlier years and similar developments may be expected in the future. It is only necessary to refer to the gypsy moth, the San José scale and the cotton boll weevil, to bring to mind three exceedingly destructive pests which were detected shortly after they obtained a foothold in the country and were allowed for one reason or another to extend their range over considerable areas. All three have been exhaustively studied and many printed pages have been devoted to discussing their habits and the most effective methods of control. With these three in mind, one might conclude that American economic entomologists have been more efficient as investigators than executives. Very nearly the same conditions obtain in relation to chestnut blight and the white pine blister rust.

A survey of the situation in the light of our present knowledge justifies the belief that it would have been comparatively inexpensive and certainly highly profitable to have attempted the extermination of these three pests as soon as they were found, even though it involved considerably larger expenditures than would be necessary after more information was available. It may be argued that eradication was impossible in the earlier days because of the lack of information. This is most easily answered by the statement that much of the most valuable data in regard to such problems come from field experience. We would not underrate in the slightest the desirability of exact informa-

tion but if we wait until everything is known very little or nothing will be accomplished.

Quarantine and Extermination

The introduction of the San José scale in the east was a prime factor in bringing about the establishment first of state and later of federal quarantines, both designed to limit and prevent the distribution of injurious insects and plant diseases. Quarantines, like other human agencies, have their limitations and if they are to attain the fullest measure of usefulness, should be supplemented by exterminative measures.

There are several fundamental weaknesses in our efforts to exterminate insects. In the first place, it appears very difficult to secure a general unanimity of opinion as to the economic status of a pest before it has spread to a material extent and caused serious losses. Such delays give the insect an opportunity to multiply and if it be reasonably active and prolific, it may within a season or two escape beyond all reasonable possibilities of control. Then there is the necessity of securing funds from the state or national government and in the case of Congress at least it is very difficult to secure special appropriations with a reasonable degree of promptitude.

These conditions are evident to all. Should we not, therefore, seek to provide in some manner or other for a reserve fund which could be utilized for just such emergencies? It would make possible the beginning of operations at the outset and at the very time work could be prosecuted to the best advantage. It of course follows that investigation and scouting should also be pushed so far as necessitated by conditions but, if we are correct in our judgment, these three activities should be in a measure coördinate and interrelated rather than one being dependent upon the others. Our present quarantine laws are the outcome of years of work and desirable modifications along the lines outlined above can hardly be expected without systematic effort for presumably several years.

Control Work and Appropriations

Practically speaking there has been no general control work in the field aside from that done by the states of Massachusetts and New York. The state of Massachusetts attempted to compel property owners to clean up infested land at their own expense, the state even doing the work and assessing the costs against the property. Subsequently the Federal Bureau of Entomology undertook a limited amount of this work in Massachusetts on a coöperative basis and late in the spring of 1918, nearly $100,000 was expended by the state of Massa-

chusetts under the direction of Mr. L. H. Worthley, detailed from the U. S. Bureau of Entomology for this work, in a systematic effort to clean up the entire infested area. Unfortunately, the money became available so late in the season that it was not possible to do very satisfactory work.

The state of New York expended nearly $100,000 in a rather thorough clean-up of all of the then known infested area and generally speaking exceedingly satisfactory results were obtained. The work was done in the belief that there were two generations of the borer in the New York area and that there would be substantial assistance from the federal government. This latter, so far as clean-up work is concerned, has not materialized. Developments late in the season clearly demonstrated that there was but one generation in the New York areas and a correspondingly slight injury. In other words, control and extermination in the cooler portions of the corn growing area of New York state, the parts now infested by this insect, is of much greater importance to the country as a whole, particularly the middle and southern corn growing states and is, therefore, a national rather than a state problem.

The work against the European corn borer both in 1917 and 1918, by the state of Massachusetts and the Federal Bureau of Entomology, was practically limited to investigations which latter have been published in bulletins cited above.

The American Plant Pest Committee should be credited with being the first organization to so fully appreciate the serious nature of the European corn borer as to adopt measures which resulted in the introduction in the United States Senate of a bill (S. 5290) appropriating $500,000 for work against this pest. Unfortunately, representatives of the Bureau of Entomology did not at that time see the need of any such large appropriation and desirable coöperation was lacking. It was intimated that representatives of the bureau were then willing that a moderate sum, $25,000, be appropriated for practical work pending the acquisition of more information during the season of 1919. This was before the insect had been discovered in New York state. Shortly after the Scotia, N. Y., infestation was reported, the secretary of agriculture was prepared to recommend $100,000 for control work and very soon thereafter the sum was increased to $500,000. An item for this amount was eventually included in the agricultural bill, which later failed to pass because of the filibuster at the end of the session of the last Congress. The Agricultural Appropriation Bill passed by the special session of Congress contained an item of but $250,000 instead of the figure accepted by the previous Congress. This bill passed and the amount named became available early in

August, altogether too late for effective work in the spring. A very considerable increase in the area of the infested region led the secretary of agriculture to ask for an emergency appropriation of $500,000 in addition to the $250,000 just mentioned and Doctor Howard submitted to the Albany-Boston conference, held the last of August, an itemized schedule showing how it was proposed to use these funds.

A special committee was appointed at the corn borer conference just mentioned and brought in resolutions, subsequently adopted without a dissenting voice, in favor of asking Congress for an appropriation of $2,000,000 to be made available for use as rapidly as an effective organization to carry on the work could be secured and developed. This was in addition to funds already appropriated. At the hearing before a subcommittee of the Senate Committee on Finance, the request for $2,000,000 was strongly urged by a goodly number of commissioners of agriculture and official entomologists from the middle and eastern states, although a representative of the Federal Horticultural Board went on record to the effect that $500,000 was all that could be used advantageously at the present time. In view of these conditions, we could hardly expect more than the smaller sum and as a very pessimistic note was shortly thereafter voiced by an Indiana official (9), it is perhaps not surprising that Congress decided to put the entire matter over until the regular session.

The secretary of agriculture has recommended to the present session of Congress an appropriation of $500,000 to be immediately available for European corn borer work. Basing estimates upon the work in New York state last spring, it would require approximately $200,000 to clean up the eastern infested area in that state and about the same amount for the western territory, a total of $400,000. Common prudence would dictate some allowance for emergencies and the possible discovery of additional infested territory. If these outlying areas are a serious menace to the corn belt, and this seems to be the consensus of opinion among economic entomologists, we can hardly recommend the expenditure of less than $500,000 in the New York state and adjacent territory.

The situation in eastern Massachusetts and southeastern New Hampshire demands that some measures should be taken to prevent an undue multiplication of the insect. There is a possibility that the funds for the demonstration project, covering about six towns in the badly infested Massachusetts area may prove to be insufficient. There is also scouting, an essential phase of the work, testing on a large scale possibilities of control by modified cropping, quarantines, etc. It would seem as though at least $500,000 should be available for work of one character or another next spring in the New England states.

If the insect is really a serious pest, and it is considered decidedly unsafe to assume otherwise, an emergency appropriation of $1,000,000, immediately available, would seem the minimum amount which could be recommended and with our present knowledge plans should be made for the expenditure of approximately the same sum in the fiscal year of 1920–21. It is believed that such a program is justified on both practical and scientific considerations. It may mean the expenditure of some money which could be used to a better advantage when we come to know the problem more intimately though this would be more than offset, in our estimation, by effective action before there has been a greatly increased spread of the pest. This program is positive, conservative, so far at least as preventing injury is concerned, and appears to be the most logical which can be adopted at the present time.

A Tentative Plan

The situation is such that it seems advisable for the writer, without in any way attempting to dictate or to suggest that his opinion is better than that of others, to outline a plan which might be utilized as a basis for coöperation between federal and state officials. It is the result of repeated examinations of conditions in eastern Massachusetts and the writer's familiarity with the situation in New York state and may well be considered as an elaboration of a plan outlined by Doctor Howard at the European corn borer conference last August.

The maintenance of such quarantines and restrictions upon the growing and distribution of corn on the ear, cornstalks and other plants or parts of plants as may be justified by conditions is of prime importance.

Special care should be exercised to avoid burdensome and unnecessary restrictions and at the same time secure at least a moderate degree of protection. We are inclined to believe that the efficacy of quarantine measures can be greatly increased by restricting cropping somewhat as outlined below and that this latter would be much less burdensome than the attempt to enforce what might be regarded as thoroughly satisfactory quarantine regulations.

Outline for Sparsely Infested Areas

1. The continuance of the publicity campaign throughout the United States in an effort to secure general coöperation in locating infestations.

It is significant, despite the limitations of this method, that the first information of the pest occurring in Schenectady and Erie counties, New York, came to hand as a result of publicity work.

2. The development and maintenance of adequate scouting forces for the purpose of quickly determining the limits of the various infested sections and also for making special examinations in any particularly suspicious areas.

Scouting is a most valuable supplement to publicity and the two should be worked together if the best results are to be secured. The Federal Bureau of Entomology already has a number of scouts at work in various parts of the country. There are difficulties in securing enough.

3. The speedy organization of a clean-up campaign for the more western areas.

This is designed primarily to destroy the wintering borers in cornstalks and weed stems in cornfields in particular. It is a direct and a fairly effective method of keeping the infestation down to the minimum, and appears to be of prime importance in checking the westward spread of the borer.

4. A measurable regulation of corn planting in the infested areas next year as follows:

(a) Plant throughout the infested territory small plots of early corn designed to attract the moths.

(b) Destroy such early plantings before the borers attain maturity in localities where conditions justify such action.

It is comparatively easy in late July or early August to locate the work of the borer in sparsely infested areas. Scouting territory where there is but one brood at this time and the prompt destruction of the occasional infested hills appears to the writer as a promising method of not only locating the limits of infestation but of restricting spread. A splendid opportunity to test its efficiency was missed last season because of the expected development of a second brood in New York state.

(c) Plant the greater part of the corn crop two or three weeks later than the very early corn and in this manner avoid infestation to a large degree.

The immunity of somewhat late planted corn in the Schenectady area was most striking, even in adjacent fields and with the same variety.

(d) Prohibit in all infested areas the growing, within fifty feet of early corn, of celery and other garden crops liable to be infested and commonly transported by commercial agencies.

There have been to the writer's knowledge no extensive tests of possibilities along this line and before we conclude that the insect cannot be controlled and prevented from establishing itself in the corn belt, we believe that some such methods should be tried over an ex-

tended area. We are only at the beginning in learning the possibilities of insect control through crop manipulation.

5. A careful and exhaustive investigation should be made as soon as possible to determine the probable origin of the scattering infestations along the southern shore of Lake Erie.

It goes without saying that a knowledge of methods of spread is a most valuable aid in preventing further dissemination.

Outline for the Earlier Infested Territory

The situation in eastern Massachusetts, especially in the badly infested area, is such as to require somewhat different treatment. It is very probable that the early planting of small plots of corn and the restrictions in regard to growing garden crops likely to be infested near corn would prove of considerable service. There is need of large scale demonstrations to ascertain the most practical methods of handling the pest in eastern Massachusetts and in time they may have to be extended to other portions of the country. There is a possibility that systematic and general work along the lines indicated below would ultimately result in a considerable decrease and perhaps a somewhat general limitation of injury.

Corn and other infested plants in eastern Massachusetts should be handled in such a way as to reduce to a minimum the possibility of borers surviving, the most promising methods being the following:

(a) Plow thoroughly, preferably in the fall and endeavor to cover the stubble deeply, since such measures undoubtedly destroy many borers.

(b) Put the corn fodder in a silo or if that is not possible cut and shred the cornstalks, even salting them so as to promote their consumption by cattle.

(c) Where other treatment is impossible, the stalks should be composted or burned provided the expense is not out of proportion to the benefits secured.

(d) Partly consumed cornstalks should not be mixed with manure unless the latter is composted or handled so it will heat.

(e) Cornfields and adjacent areas should be kept free from weeds and nearby weedy areas at least should be burned over during the fall or early spring.

The situation in eastern Massachusetts is so serious that we believe it to be of national importance to test possibilities on a large scale and for this purpose we would favor the expenditure by the federal government of a liberal sum the coming season, possibly $500,000 in work of this character.

Briefly, the urgent need is for a large appropriation, the larger the

better, to be used in testing on a comprehensive scale any measures likely to give a considerable degree of relief and greatly delay if not prevent the invasion of the corn belt by the European corn borer. The conditions are such that we question seriously the wisdom of making demonstrations on such a limited scale as will permit the pest to greatly extend its range during the season or seasons this practical work is in progress. We must endeavor to hold the insect and at the same time ascertain the possibilities in relation to control.

VICE-PRESIDENT RUGGLES: This paper is now open for discussion.

MR. C. L. MARLATT: I hope this body will not be alarmed at the volume of the documents I am carrying. This bundle includes a few papers to which I may wish to refer.

I agree with Dr. Felt heartily as to most of his discourse. I hardly think he will want me to agree with his criticism of a certain member of the Horticultural Board. I am glad to say that this criticism is founded largely on misinformation. The facts are all a matter of record. The $500,000 supplemental estimate, to which he referred and which is still before Congress, was transmitted to Congress by the Secretary of Agriculture on July 29, 1919, in connection with an urgent deficiency bill then under consideration and, therefore, long before the hearing granted by the Senate Committee to representatives of various states on October 8 following. The first hearing on this estimate was August 23, 1919, at which hearing Messrs. Quaintance and Walton of the bureau presented the argument as to the needs for the money. Both Dr. Howard and the speaker were at that time absent from Washington. At the hearing on October 8, 1919, both Dr. Howard and the speaker were present. The speaker's remarks were chiefly in calling the attention of the committee to the Secretary's letter in which is voiced and explained the need for the additional $500,000 to meet the corn borer situation during the season of 1919–20. The speaker is perfectly willing to accept the responsibility for whatever influence he may have exercised in developing the determination of the amount which was so recommended.

DR. FELT: May I ask just one question? I thought, and I am speaking in all honesty, that you said that $500,000 was all that could be used.

MR. MARLATT: I pointed out that that was the amount submitted by the Secretary of Agriculture and that that sum, with the existing $250,000, making a total available fund of $750,000, was believed by the department to be sufficient to cover the survey and cleanup work which could be wisely and profitably carried out in the season 1919–20.

The amount of funds that can be so utilized is a question which

interests us all. To determine the funds needed and the work which should now be undertaken, we must consider the known facts concerning the corn borer. We do not want argument or mere statement of opinions. As a body of technically trained men who are the advisers of the farmers of the country, and of the legislators of the different states, and of Congress, we can recommend only what we believe to be justified. We have reputations as entomologists and practical men which we want to maintain, and we should realize that our recommendations will be passed upon by men quite as competent as ourselves, to judge their urgency and reasonableness. They must be supported, not only by actual conditions establishing the urgency, but also by a real possibility of accomplishment of the work planned. Neither Dr. Howard, representing the Bureau of Entomology, nor the speaker, representing the Federal Horticultural Board, could afford to go to Congress and make exaggerated statements both as to damage and possibilities of extermination to dislodge huge appropriations of money. The members of these Congressional committees know a great deal about these problems and have often very definite ideas as to the needs. If you went before these men as often as I do, you would be surprised to find how much they know about these things and how fairly they appreciate the hue and cry that has been made about various pests that have come up in recent years and which have been represented as threatening the fabric of the country and they have noted that this fabric has not been rent asunder! We have lived through the period when the fruit crop of the country was going to be wiped out by the San José scale and have even lived to see this same scale rated by many as the greatest blessing that has ever come to the fruit grower. We were led to believe that the potato industry would be wiped out by the powdery scab, and large appropriations were obtained from Congress and spent in attempting to stamp out this disease. Later we discovered that our control work was absolutely futile and that we were simply wasting money and making ourselves foolish and, with a huge appropriation unspent, the work was stopped. That disease has scarcely been heard of since. It disappeared with the termination of its exploitation!

It does not follow that this will be the case with the corn borer. We are fairly agreed that the corn borer is a new pest to this country and that it attacks corn and other crops. Any new pest that attacks important crops is of importance. In everything that I have said about this insect I have indicated that I realized its importance and that its power for harm had been demonstrated in Massachusetts. When this insect was new to us and we saw the damage it was doing, the statements which now may seem exaggerated were perhaps justi-

fiable, but we have now had two years of careful study of the insect. What are the conditions today? They have been enumerated in part by Dr. Felt. Several of these are very hopeful and should very materially affect our attitude and recommendations with respect to the corn borer. We should look at these important modifying considerations fairly and not try to conceal any of them or push them aside on the fear that they may affect our appropriations and affect the public's appreciation of the subject.

My experience with Congress for over thirty years has been that by frank statements one gets a great deal farther than by exaggerated statements. In this way, for example, moneys have been secured for the pink bollworm work. Appropriations of $500,000 and $600,000 have been obtained on the statement that the money was wanted as an insurance fund which might or might not be used. We have not represented to Congress that the cotton crop will be doomed unless the sums were given, but a plain statement of conditions has never failed to get what was needed.

Now what is the situation with respect to the European corn borer? It was discovered only a few years ago, but we now have every reason to believe it has been in this country for ten years. I think the evidence of this is sufficiently clear to leave very little reasonable doubt. In the years 1909 and 1910 there was a great shortage of broom corn in the United States and nearly 10,000 tons of this commodity were imported chiefly from Austria-Hungary. Of that enormous mass of broom corn some 500 or 600 tons, a comparatively small portion of the importations, went to a factory in Boston, and a similar amount to the eastern New York invaded district. Approximately eight tenths of the total importations went elsewhere, most of it into the Mississippi Valley, to New Orleans, St. Louis, Chicago, and points in Kentucky, and was distributed from these centers to many, perhaps hundreds, of broom factories. We have made very little investigation of that distribution of broom corn, in fact, we have just begun it. We have traced a few of the shipments to destination and have made a very brief investigation of the field conditions surrounding those factories. This tracing and field inspection work is now temporarily discontinued, due, I am advised, to the unfavorable conditions entailed by midwinter. We expect to continue this work next season making a thorough investigation of the whole Mississippi Valley region to determine how widely the insect may have been carried by such broom corn.

Of first importance is the determination of the distribution of this insect in the United States. In 1918 the inspection force was very limited. This year, shortly after the Congressional appropriations

became available in July, Mr. Worthley, who had been put in charge of the cleanup work, was also assigned the charge of the inspection force, and the force of trained men for this purpose was enormously increased. Instead of the half dozen inspectors of the year before we put upwards of a hundred men into this service. Nearly 100 inspectors were assigned to Massachusetts, a group of 20 or 30 to New York, and later in the season others to Pennsylvania, Ohio, Indiana, Illinois, and elsewhere in the Mississippi Valley. As a result of that greatly enlarged inspection service our knowledge of the distribution of the corn borer has been very greatly increased. Its present known distribution has been pointed out by Dr. Felt and that the insect has not been found west of New York or Pennsylvania. This was not a sudden spread of the insect from last year, though it has been very frequently so described, but was rather merely the determination of additional territory, some, and perhaps much, of which had been infested probably for ten years. That we have now determined the limits of the distribution of this insect is not at all likely, as is evidenced by the known distribution of the imported broom corn just described and the very fragmentary nature of the surveys, even where they have been most thoroughly conducted.

I should like to discuss now for a moment the evidence indicating the economic importance of the insect as indicated by its abundance and the amount of damage it has occasioned to corn. Its damage to other crops is chiefly significant as indicating that such crops may be a means of disseminating the borer.

Over much of the infested area in coastal Massachusetts and New Hampshire, the insect is very rare. I have here records submitted by Messrs. Worthley and Caffrey indicating the results of the scouting work in Massachusetts and other states. These records apply to the new areas of infestation determined in 1919, practically all of them subsequent to July 1. In most of these towns or townships the actual findings of larvæ were limited to from one to a very few and in most cases these after several days of intensive search. The number of larvæ recorded is not always, however, indicative of the extent or amount of infestation because as a rule, after finding an infested field, the inspectors went on to other townships. The amount and extent of infestation is, however, indicated by the number of man days spent in a township, and the number of fields inspected before the borer was found, and also, to some extent, by the number of larvæ found in such fields. On the other hand, the reporting of a large number of larvæ in a township is also not indicative of very much. For example, in one township the record is given of over 40 larvæ being found, but the statement is made that this town contains over 40

square miles and that actually the percentage of infestation of this township was very light. Looking at it one way, this record shows only one larva to the square mile after a painstaking search!

The inspection work with respect to the corn borer has been necessarily limited. Time and funds have not been available for intensive work such as has been done, for example, in the pink bollworm surveys in Texas. As an illustration, Dr. Hunter reports that 209 man days were spent on a single cotton field, that is, 1 man 209 days or 209 men 1 day. On the 209th day a single worm was found. After that 100 other man days were spent in the same field without finding another worm,—that is, intensive search. We have not been able to make that sort of intensive search in the case of the corn borer, but undoubtedly in a great majority of the towns in Massachusetts and elsewhere where the insect has been found it would probably be a very difficult matter to recover the insect again. The records indicate, however, that the insect is still rare over much of the district that it now invades and over which, in large part at least, it has been in existence for a considerable number of years.

In this connection Mr. Worthley states in his letter transmitting these tables that "it is rather difficult to give much of an estimate of percentage of stalks and ears infested in these different fields. I am sure, however, it does not exceed 1 per cent as an average." The tables referred to are submitted herewith.

The full records of the survey work in the latter half of 1919 in the states now known to be infested and in other states is also a matter of interest—the survey in the infested states extending very much beyond the area actually found infested. Records are not available for Connecticut, Indiana, Kentucky, Illinois, and other western states, where some work was also done late in the season.

In New York state the same conditions as to the spread and abundance hold true, only the insect is much more rare on account of its single broodedness in that state.

The corn borer situation in New York and in Massachusetts has been investigated independently by three or four different bodies of experts outside of the working forces of the Bureau of Entomology. It was investigated by the Federal Horticultural Board three times, twice in August and again about the first of October. The representatives of the board went over the ground very thoroughly, not merely going through the special exhibit fields, but stopping at many others. A good deal of difference was noted in those selected for the board to inspect and those within the district taken at random. Again, a body of corn technologists, specialists of the Bureau of Plant Industry of the department, went over these areas in New York and Massachu-

setts in September to see if it was desirable and necessary to develop a resistant corn which would be immune to the corn borer. They came

INFESTATION INDICATED BY SCOUTING OF 1919

Township	Man days	Number of fields examined	Number of fields infested	Number of larvæ taken
New Hampshire:				
Kingston	35½	328	1	7
Plaistow	5	50	1	7
Seabrook	4	29	1	4
Massachusetts:				
Abington	3	86	1	1
Avon	8	238	1	2
Bedford	1½	2	2	6
Bourne	9	55	1	5
Bradford	1	1	1	7
Brewster	4	12	1	few
Brockton	3	41	3	5
Concord	2½	1	1	1
Duxbury	8	98	1	1
Framingham	20	416	3	2
Georgetown	*	*	3*	few
Hamilton	1	1	1	2
Hanson	14	339	1	6
Kingston	25	269	2	16
Merrimac	1	58	1	1
Methuen	1	1	1	6
Middleboro	42	679	3	17
Natick	1	1	1	2
Orleans	20	184	1	1
Pembroke	12	119	1	few
Plymouth	30	619	6	43
Provincetown	3	11	1	8
Sudbury	9	238	1	few
Truro	4½	26	2	6
Tyngsboro	8	108	1	2
Wellfleet	6	25	1	7
Western New York:				
Brant	4½	7	3	36
Cheektowaga	2	26	1	2
Collins	6	23	1	1
Dayton	¾	6	1	1
Eden	3	16	1	few
Evans	1½	5	2	4
Hamburg	7½	34	1	1
Hanover	1½	4	1	1
North Collins	3	13	3	4
Persia	3⅛	17	1	3
Perrysburg	1½	4	1	1
Pomfret†				
Sheridan†				

* Scouted by State Board.
† No record.

back with views of the situation which corresponded closely with those of the board. Early in October a commission from Indiana headed

by Dr. C. G. Woodbury, director of the State Experiment Station, went over the same ground. This commission included also the state entomologist, Mr. Frank N. Wallace, Mr. L. M. Vogler, representing

Record of Field Infestations by States, 1919

Townships	Number of townships inspected	Man days	Number of fields examined	Number of fields infested
New Hampshire	37	979	8,727	3
Massachusetts	146	1,015	22,928	42
Eastern New York	60	983	4,758	37
Western New York	46	179	1,162	16
Pennsylvania	10	13	311	0
Ohio	16	29	381	0
Rhode Island	1	12	72	0

the farm associations of Indiana, and Mr. William H. Larrimer, an entomologist of the United States Bureau of Entomology in charge of a field station at Lafayette, Indiana. I have here the reports from Dr. Woodbury and Mr. Wallace. They are in substantial agreement with the viewpoint of the board and of the department. That is the way the corn borer situation impressed these independent bodies of men who were fully competent to determine what the insect is really doing.

I wish now to discuss certain hopeful features that put a rather different aspect on the corn borer situation.

The first of these is the factor of the number of broods. The fact that it is single-brooded in New York state has been pointed out by Dr. Felt. As a single-brooded insect its damage in that state has been negligible. In October, I asked Mr. Van Buren, who had charge of the corn borer work in New York, how much damage it had done in New York state. His answer was that it had done practically no damage.

In Massachusetts the insect is double-brooded and the damage has been severe in special fields, but taking the area as a whole, as already indicated, the percentage of damage is very low. I doubt, however, if any of the fields have shown more than 10 per cent damage. Understand what I mean by 10 per cent. I mean 10 per cent loss of corn. I do not mean 10 per cent of stalks infested.

It has been stated here that the damage in the season 1918 was even worse than in 1919. I have here the statement of Mr. S. C. Vinal on the damage of the 1918 crop. It will be remembered that Mr. Vinal is the man who discovered the corn borer and was in charge of the work for Massachusetts until his sudden death last winter from

influenza. Mr. Vinal was altogether an exceptional man and his death is a great loss to applied entomology. His statement made at the board hearing of August 27, 1918, in answer to a question as to the damage actually caused by this insect to field corn and sweet corn, is as follows:

> Field corn is not grown very extensively around that area. We have been trying to find field corn but it is pretty hard to find it. The only way we can get it is to plant it ourselves. From a farm of five acres of very early sweet corn that I have been working, when that corn was picked and shipped to the market I should say there must have been 10 to 20 per cent of it containing larvæ or pupæ, either in the corn or in the butt. But as far as the injury to that farmer is concerned, he did not lose a cent because the consumer lost it. His corn went to the market and sold as early corn at the same price as other sound corn. Of course the consumer was the loser

That was at the end of August, 1918. From 10 to 20 per cent of the ears or of the butts or stems of the ears was infested. The damage to an ear of corn infested by this insect rarely exceeds the damage occasioned by the ordinary corn earworm. The exhaustive studies of the latter insect by Dr. Quaintance indicated a loss of 7 per cent to the infested ear in actual grain. Seven per cent of 20 per cent gives you 1.4 per cent actual loss in grain, and that is taking the highest estimate given by Mr. Vinal and making no deduction for the worm in the butts! The possibility of even such loss to corn makes the insect important, but it does not indicate doom to the corn crop of America! I think I can say fairly that I have seen certain fields, two or three, in Massachusetts in 1919, which have shown damage equal to that mentioned by Mr. Vinal, if not exceeding it. Here again we want to get all the information possible and to give such information proper weight.

The factor of number of broods or number of generations which this insect may have annually is, therefore, of great importance. Wherever the insect is double-brooded the damage will undoubtedly be greater. In coastal New England the double-broodedness is apparently due to the influence of the Gulf Stream. The New York climate, however, in both the eastern and western areas invaded, carries over a good deal of the important northern half of the corn belt and single-broodedness can be reasonably anticipated over most of that area.

The second hopeful feature is the substantial immunity of field corn indicated by the experience of 1919. In his reference to this factor, Dr. Felt failed to note that the corn crop of the large area in western New York is practically all the common coarse field corn. In this area the insect has been confined to the stalk and is so rare that our records indicate about one fifteenth of a worm to the square mile! That is not eating up the corn crop, is it? The corn borer has un-

doubtedly been in this western New York area eight or ten years to have gained the existing spread and, therefore, the absolutely negligible damage to field corn in this large area is a very strong support of the immunity of such corn.

The third point which I wish to make is the strong indication that clean culture will very largely limit damage by the corn borer. In Massachusetts, where the insect is doing its greatest damage and where it is double-brooded, the worst fields were weedy fields or fields surrounded by weedy areas. The general weediness throughout the Boston area has undoubtedly very much increased the abundance of this corn borer. I do not want you to take my dictum only on that factor. I wish to read a statement from Mr. Worthley who goes vigorously into this subject. It was made at the hearing in Boston last August and is as follows:

> We made a special examination for this hearing of fields and we found especially in celery fields a great amount of weeds. We would like to plead with the market gardeners as evidently it must be a good crop to try to keep the weeds down as near as possible and help us in control measures. One of the celery fields I visited recently is worth probably $100,000. While we found no borers in the celery, we found them in weeds right adjacent to the celery. They have a large force of men working on the place and for a couple of hundred dollars they could have cleaned up those weeds and there would have been no borers. It seems to me with the large amount of money involved in these market garden crops, a small percentage might be laid aside to keep the weeds down and this will help the work just that much more. I hope the members of the Market Gardeners' Association will appreciate that and that will make our money go much farther.

In response to this, Mr. Ballinger, representing the Market Gardeners said:

> The gentleman who has just spoken has brought up the subject of weeds. . . . He wants us to keep the weeds down. Where can we get labor? It is easy enough to say that but where do we get the labor? . . . It is practically within the same period that the borer has been in existence that the farmer has been short of labor. We all know that we have had more weeds during that time than at any time before.

The several commissions that I have mentioned have all noticed the weed factor and that the fields worst damaged were either weedy or surrounded by areas of weeds. The gardeners and commission men at the hearing in question pointed out that this condition had been particularly bad since the war. The inability to get labor has resulted in general neglect of headlands and vacant fields and lots and roadsides. Often labor has not been available to weed out even the planted fields. Many of these weedy areas are even worse attacked than cornfields. The corn borer works not in some fifty plants, as mentioned by Dr. Felt, but in a hundred different plants, as now known, and the small patches of sweet and flint corn in the Boston area have

apparently attracted the insect from the surrounding weeds and thus become worse infested. Clean culture, therefore, may prevent much of this loss.

The fourth helpful factor is the effective work on the second brood in Massachusetts in the season just passed of the egg parasite, *Trichogramma minutum.* It is possible that this parasite cannot always be relied upon, but with respect to the second brood in 1919, this egg parasite, on the authority of Mr. Caffrey, destroyed some 43 per cent of the egg masses as a whole, and in some fields parasitism reached 75 per cent.

As decidedly hopeful factors, therefore, we have (1) for the northern areas of corn culture, single-broodedness with accompanying negligible damage indicated; (2) possibility of cultural control by the elimination of weeds; (3) the immunity now indicated for ordinary field corn, and (4) the possibility of effective egg parasitism. All these factors should be taken into consideration in estimating the future importance of this insect as a basis for determining what appropriations we should ask of Congress for control work, also the other factors of distribution, food plants and cost, as affecting any program looking to possible extermination.

Before discussing what can be done in the way of control work, including prevention of distribution, I wish to refer again for a moment to the subject of extermination. I hope we have all given up the idea of extermination, at least with the exception, perhaps, of Dr. Felt. No one would like to see the corn borer exterminated more than the speaker, but suppose I do not give you my opinion at all (laughter), but instead let you have the judgment of the experts who have been working with the corn borer longest and know most about it. I have here a statement made by Mr. Caffrey, who has been studying this insect intensively for some three years and perhaps knows it better than any other person. At the hearing in Boston last August he was asked whether the corn borer could be exterminated. He replied "I think the statement was made that if we had unlimited funds and unlimited authority it could be done. I think that covers the ground." He goes on "I cannot imagine any condition under our democratic system of government in the United States where we could realize these conditions. It would amount to giving us authority to go into any man's property and if we found a few in his celery, or a few in his weeds, or corn, to dig up everything and keep everything out that year and possibly the next." He was asked "How would you get distribution?" He replied "That would depend upon your funds. If you had unlimited funds you could, if necessary, put a couple of million men in the field to examine every stalk." In the same connec-

tion Mr. Worthley advised me that there are 20,000 miles of roadway in the old 400 square miles of area in Massachusetts. To go over those roads is equivalent to a trip seven times the distance from Boston to San Francisco! Those roadways are more or less lined with weeds and are bordered with private estates. There are over 300,000 of such estates in the old limited area in Massachusetts and the added area now increases these many times. The insect breeds in 100 different plants. If we cannot determine distribution except by the employment of 2,000,000 men examining every weed, we have no right to spend millions of dollars in efforts at extermination here and there, only to find that the insect occurs all around us. We should have wasted that money. I do not think anything more needs to be said on the subject of extermination.

Practical control work is, however, another matter. The discussion of legitimate control work with respect to the corn borer brings us to the subject of state and federal quarantines. The Federal Horticultural Board was early requested to quarantine the invaded territory in Massachusetts. Such quarantine was established covering the then known infested district with respect to corn. Following the determination of the wider spread of the insect and its discovery in New York, additional hearings were called for the purpose of extending this quarantine both as to district and subject. At these later hearings the officials of Massachusetts and New York were less anxious to have federal quarantines and requested that the matter be left in their own hands. Various reasons for this were urged. A federal quarantine being limited to interstate control would, in a sense, cover the whole state and would put a sort of blight on the state. I cannot go into the full argument. At any rate we yielded to it but only upon the agreement on the part of the representatives of the states of Massachusetts and New York that quarantines would be promulgated by these states that would prevent movement out of the infested territory of any products likely to carry the insect. Such quarantine orders were shortly thereafter issued by the Commissioners of Agriculture of Massachusetts and New York. The quarantine in Massachusetts has been extended five or six times, but has remained as applying to corn only. The New York quarantine has not been extended to cover the new areas of infestation. There was perhaps excuse for not promptly extending these quarantines. New territory and new food plants were being determined so rapidly that quarantine action could not well keep up with this increased information. Every day added a new township or a new county. The knowledge that the broom corn, that had probably brought the insect to Massachusetts and New York, had been widely distributed throughout the middle

west gave a broader viewpoint and indicated that there was every possibility that the insect was widely distributed throughout the eastern half of the United States. Another important consideration was urged with respect to a federal quarantine, namely, that it would interfere with the necessary movement of food products. The absolute need in the case of several New England states of the food articles which would have to be controlled as to Massachusetts was clearly brought out at our hearings, and commissioners and other representatives of these states asked us not to place general quarantines because of these needs. The situation, therefore, is practically this: Are we justified, because we have been clothed by Congress with authority, in placing very hurtful restrictions on large areas of the country on account of what may perhaps be, after all, an unwarranted fear? Are we justified in taking such action, with the evidence indicating that the insect has been very widely distributed, before opportunity is offered for the determination of such distribution and with the area being constantly added to?

If we expect to be listened to and have our requests granted, we have got to take a sane viewpoint of the situation and present such viewpoint. We cannot, in justice to ourselves, put our heads under the sand and say we won't see these conditions, and go ahead with the idea that the corn crop of the country is doomed unless we begin at once to exterminate the insect.

I asked Commissioner Wheeler at one of these hearings how he proposed to exterminate the borer. His answer was substantially "Perfectly simple. Begin at the outer edge and push it into the sea." That is the easiest thing in the world to say, but a very different thing to do. He tried pushing the insect into the sea with his own funds and, in spite of the fact that we have been told that that clean-up work resulted in a lot of good, I have here statements from competent observers that it was practically of no value.

Mr. Caffrey at the Boston hearing in August, 1919, made the following statement:

> As a result of the clean-up work which was done last year we rather hoped that the degree of infestation would be reduced but we find that right within the area that was commonly supposed to be heavily infested that the plants are infested to a greater extent than they were last year.

Mr. C. G. Woodbury, head of the Indiana Commission, in his report, says:

> Much clean-up work has been done at state and federal expense in this territory; the effectiveness of such work is questionable. There are fields which were not cleaned up last year but which nevertheless have a much smaller infestation of borers this year than last. On the other hand, there are certain fields in which as high as

$75 per acre were expended in clean-up work in which the borers apparently were more severe this year than they were last year.

I wish here to insert a word to correct a misapprehension which seems to be widespread with respect to the alleged delinquency of Congress and the consequent wide extension of the corn borer. It has repeatedly been intimated that the corn borer extended its range to many times its area of last year because Congress did not give immediately the sum of $500,000 for exterminative work. The facts are that the first estimate submitted to Congress—and the amount was only $25,000—came before the Agricultural Committee for discussion in a hearing on January 8, 1919. As a result of a special hearing, February 12, 1919, on the European corn borer by representatives of several states, there was inserted in this same bill in the Senate under date of February 22, 1919, an item of $500,000 to meet the corn borer emergency and the $25,000 item for the bureau was dropped. The various exigencies which prevented action on this appropriation bill and also prevented the securing of a like appropriation in an emergency deficiency bill before the 4th of March were due to post-war conditions in Congress which affected all legislation.

No hearings on the Agricultural Appropriation Bill for 1917–20 were held by the succeeding Congress but the Secretary of Agriculture submitted a memorandum recommending that both the item for $25,000 for the Bureau of Entomology and the special item of $500,000 for control work be included. As eventually passed by the succeeding Congress, July 24, 1919, the bill carried the appropriation originally requested, of $25,000, and a special appropriation of $250,000. These two appropriations are now carrying on the work. The most, therefore, that could have been gained by an immediate action of Congress would have been an availability of this fund for work in 1919 prior to the season for planting crops, the same sort of work which was actually conducted under state funds over much of the area with results which have already been discussed. It is utterly illogical to represent that the insect spread over all the new area now known to be invaded because Congress did not immediately give $500,000. The facts are as already indicated that the spread of the insect has been a slow ten-year process and there is nothing to indicate that the spread of 1919 was essentially more rapid than it had been during the previous year or years.

Our position with respect to this appropriation, I think, has perhaps been sufficiently set forth. We could not with our information ask Congress for huge sums for exterminative work which we believed to be impracticable and impossible. We could and did represent to Congress that we had here a new corn pest that had shown enough

damage in Massachusetts to indicate its importance and that we wanted sufficient funds to determine such importance and whether it could be controlled and incidentally if there was any possibility of extermination, and that we wanted to take quarantine action to prevent spread. To accomplish this general purpose we inaugurated a program of survey work which has now been stopped by the winter but to be renewed with increased vigor next season. Then we wanted to test the possibility of intensive control in an area large enough to make the results significant. This project is now being carried out in an area including half a dozen townships in Massachusetts. When this area was selected, it was a section running from the outer border of the infestation inward so that it would be a real clean-up as far as it went. It is true that later discoveries of distribution have made this area more or less central but the methods which are being developed and the results which we hope to gain will be valuable as indicating the possibilities of such intensive control.. No one imagines for a moment that we are going to exterminate the corn borer in that area—that is, anyone who really appreciates what extermination demands.

In concluding, I wish to repeat and emphasize what I said at the beginning that as technical men with reputations worth keeping, and if we expect to be listened to and to have our opinions given any weight, we have got to keep away from ungrounded theory and make our recommendations in terms of common sense. In other words, steer clear of what anyone will recognize as impracticable and hold only to what can be shown to be possible of reasonable accomplishment. We have got to have intelligent basis for our recommendations and we believe that such basis can be obtained by an additional appropriation at this time of $500,000 which with the other funds available will make $775,000 for the corn borer for the seasons of 1919 and 1920. If the results of this work, which we look upon as fundamental and necessary for the right appraisement of the problem, should indicate the need of larger appropriations, we will then be in position to intelligently present such need to Congress.

Mr. E. D. Ball: I have been very much interested in the two discussions of the corn borer, and also very much interested in what I saw of it in the fields, but it seems to me that what we need now is a fundamental viewpoint in this matter. This is either an injurious insect which is going to be more or less of a menace to the corn crop, or else it is not. If it is not an insect that is going to do any injury to the corn crop, and is not a menace, then neither the states nor the government is warranted in putting any money up to fight it. If it is an injurious insect every possible effort should be made to control it

because we know enough about it to know that it will be difficult or impossible for the farmer to fight it.

We have heard today that it is an injurious insect and we have heard that it is not an injurious insect. Our friend from Indiana who went down and looked over the situation reported that it did no damage, and then he went back to Indiana and recommended that they put on a strong quarantine for fear it would get into Indiana. (Laughter.) That was one of the most beautiful pieces of contradiction that I ever saw in American literature.

We heard conflicting stories at the Boston meeting as we are hearing them today but we saw enough of its damage to be satisfied that if this insect gets into our canning regions, and apparently it is driving in that direction, it will put a very great damper on the canning industry. The corn worm is bad enough, but it comes in from the outside and you can see it and cut it out, but a worm that bores into the stalk and up into the ear from the inside will do more damage. Three or four caterpillars ground up and turned out in a can of corn will not make a very desirable dish.

If we have determined that it is an insect that will do an appreciable amount of damage then we want to know whether it is possible to fight it in any way? Can its spread be stopped? The question of spread is a matter of great importance. What you do this year is worth ten times what you do ten years from now or five years from now. (Applause.) While I recognize the value of thorough and extensive scouting, we know that the history of every effective piece of control work along these lines in this country has been a history of scouting followed up immediately by *action*. Of what value is all of the scouting that you can possibly do in the whole United States if it is not to be followed by anything else? The fact remains today that the state of Massachusetts and the state of New York in good faith put up $100,000 or more apiece to undertake to hold this thing in check and to eradicate it; that up to the present time the United States government has not spent a dollar nor done anything that is intended to prevent the corn borer from spreading to the great corn district of the west. The only money they have spent on eradication or control is being spent inside the infested area in Massachusetts which is of no value in holding it from the west.

We of the corn belt are interested primarily in the western extension and spread of this insect into New York and Pennsylvania, because if it is to be kept out of the corn belt, there is the place to spend the money first. If they can make a success of eradicating that slightly infested area, then they might be warranted in spending money in Massachusetts. If they cannot make a success of that, then there is

no use spending large sums in Massachusetts. The western frontier is the place to begin because there is where the battle will be won or lost. If the government representatives honestly believe that this insect cannot be controlled we will all respect and admire them if they will stand up and say so. We will then know what to do next; but as long as we cannot get a statement of policy, we are very much handicapped. We would like to know what the government is really and seriously intending to do about the corn borer. The great corn center of this country is vitally interested in that question.

MR. E. P. FELT: It seems desirable to correct one or two impressions. I am very well aware that one can go into the European corn borer territory either in New York or Massachusetts and find a variety of conditions, many diametrically opposite. It is not the conditions but what they signify which is really important. It is my impression that Dr. Marlatt has not correctly estimated, presumably unintentionally, the infestation in western New York. There are fields in that section where it is comparatively easy to find several hundred borers per acre and generally speaking it is not difficult to draw the line between infested and uninfested territory. This does not harmonize very closely with figures given above and tending to show a very sparse infestation. The discrepancy simply illustrates the necessity of interpreting data and making due allowances for the conditions under which they were obtained. We found last spring that we could go into a section and approximate the infested area very closely. This was done during midwinter and fortunately operations were greatly facilitated by a remarkably light covering of snow. Eight or ten inspectors of the Department of Farms and Markets, working under such unfavorable conditions for three or possibly four weeks, established the approximate boundaries of the infested area. The findings of that time, it is a pleasure to state, were largely justified by subsequent developments.

From my knowledge of the New York areas I feel that there are moderately definite limits to the infested territory in both the eastern and western portions of the state and that it is practical to follow up the general line of work undertaken last spring and keep the insect down to a minimum in an effort to check its spread to other sections.

It appears unsafe to assume that it may be found in other parts of the country. We cannot say that it does not occur in remote areas and on the other hand we fail to find in this possibility a justification for relaxation in effort or a material modification of policy.

The situation in New York state with its limited injury is such that it is impossible to obtain a large appropriation for clean-up work because the matter is of more importance to other states than to New

York. In other words, residents of the corn belt must look to the federal government for this protection.

MR. C. L. MARLATT: May I venture to say a word on the policy or plan of work of the department concerning which there seems to be a feeling that such plan is indefinite or unannounced. I have attempted to indicate such policy and have apparently failed and may have no better luck this time. The policy of the department has been frequently outlined. Dr. Howard gave in detail our plan of work in August at the meeting in Albany. It is printed in the report of that meeting. Similar statements have been presented repeatedly to Congressional committees in the Senate and House. These statements have also been printed. This policy or plan of work was included in general terms in Dr. Howard's annual report for 1919 and also in my report for the same year as chairman of the Federal Horticultural Board. Apparently these statements of policy have not been understood or have been ignored.

The policy of the department takes into consideration the probabilities of the wide distribution of the insect, its hundred odd food plants and the possibilities of control of spread and of practical clean-up work. We realized the business viewpoint which Congress would take of the matter and the necessity of demonstrating the possibilities of accomplishment before such appropriations as were discussed at the Albany meeting could possibly have any status. At this meeting at Albany an appropriation of $10,000,000 or more was seriously considered but as a result largely of representations urged by me was finally brought down to $2,000,000.

To repeat it again, the program and policy of the department is to make as promptly as possible a thoroughgoing investigation to determine the actual necessities of the case and the possibilities of control. The first consideration under this plan is the determination of the distribution of the insect; second, to demonstrate on a large scale what may be done to control it; and, third, to coöperate with the several states in quarantine and other measures to prevent spread. A study of the insect to determine its importance and the biological factor is under way as you know and will be pushed to the utmost. We believe that this preliminary work can be fully carried out on the funds indicated, namely, $775,000. Until we have determined these fundamentals, we are not in position to appeal to Congress for vastly larger sums. This in general is our program and it has been repeatedly stated.

I quite agree that in a program of this kind the sooner the needs can be determined and practical work can be instituted the better. In practically all similar problems, the securing of adequate informa-

tion and determination of a plan that has promise of success have been the preliminary steps. This was done in the case of the citrus canker and pink bollworm but these were subjects limited to a single host plant and the problem was comparatively simple. The corn borer is on an entirely different basis. With respect to the delay, it must be remembered that the corn borer has evidently been in this country for some ten years and that the risk of spread is now much lessened by protecting quarantines which can be and will be strengthened.

Mr. W. E. Britton: I do not want to criticize, but I would like to ask why no scouting will be done in the Mississippi Valley this year. I realize that a careful examination cannot be made in all of that territory, but it seems as though some scouting could be done during the winter. It might be possible to determine whether the insect is present. It might be found and that would change the plan of work for next season, and possibly save considerable time.

Mr. C. L. Marlatt: The corn borer work for the bureau is in the hands of Mr. Walton and the scouting is under the direct charge of Mr. Worthley. The reasons for discontinuing scouting I have already given in part. These are largely unfavorable winter conditions and the economical use of funds. It seems much more desirable with the funds as they now are to continue the work next summer when the insect will be more easily discoverable. In practically all the new territory the insect is so extraordinarily rare that it is very difficult to find it in the stalks under winter conditions and it will be easier perhaps to detect its early work in the tassel next summer. It is largely a matter of using the men and money to the best advantage. Furthermore, we are limited as to funds. The $500,000 additional appropriation has not yet been granted.

Adequate quarantines, together with such field and district control as is practicable, are the important means of preventing wide jumps by the movement of infested products. In such quarantine work the states of New York and Massachusetts started valiantly but they have not lived up to the promise which this start indicated, a condition which has only recently come fully to the knowledge of the board. This situation will probably necessitate a federal quarantine and in fact a notice of hearing for such quarantine has already been tentatively drawn. The reasons for not taking federal action supplementing the original quarantine as to Massachusetts have already been explained.

Mr. George A. Dean: I have been very much interested in what has been said about the introduction of broom corn. Is there any way of determining whether the shipments were made in the Mississippi Valley? I think some of the states have funds with which they

could do their own scouting. I think it would help if we knew where this broom corn was distributed.

MR. C. L. MARLATT: Mr. Harrison E. Smith, in Mr. Walton's service, has had charge of the investigation of the distribution of this broom corn. Two shipments were traced as far west as Iowa. We do not know where the great bulk of the shipments went except that they were variously distributed in the Mississippi Valley. We knew of some points where this broom corn was used. It is a matter of considerable time to find these records buried in various business houses. In the case of the pink bollworm, we have been two or three years tracing the distribution of the Mexican cotton that entered in 1916. It takes time to do such work.

MR. J. G. NEEDHAM: Mr. President, it seems to me that our want of agreement over the policy of the Bureau of Entomology with respect to the European corn borer grows not so much out of any difficulty of understanding that policy (for it is clear enough), as it does out of the fact that that policy seems not to cover one point about which a good many of us are a bit apprehensive. It seems to omit all thought of checking the invasion at its front. Scouting and all the rest are well enough—none of us wish to curtail these activities, but should we be content with scouting and study while the invader is extending its range?

The corn borer may ultimately prove to be a blessing in disguise, like the San José scale and the boll weevil and the other imported pests with which it has been compared here today. But it may, like these also, for a time seem more like a devastating fire, able to sweep an important industry before it over a considerable area of our country. Shall we let the fire alone, taking chances in its doing little harm? That is the question. If not, it would seem that the place to fight it is where it is advancing farthest and threatening most harm for the future.

Owing to the sudden discontinuance of the electric current, the session adjourned in the dark.

Report of the Section on Apiculture

Wednesday Evening, December 31, 1919, 8.20 p. m.

The meeting was called to order by Chairman W. E. Britton, who presented an address entitled, "Some Phases of Beekeeping in Connecticut."

SOME PHASES OF BEEKEEPING IN CONNECTICUT

By W. E. BRITTON, *State Entomologist, New Haven, Conn.*

The state which I represent, Connecticut, is a small state, having an area of 5,004 square miles, and a population in 1910 of 1,114,756.

It has approximately 100 miles of sea coast and its highest altitude is Bear Mountain in the northwest corner, 2,355 feet. In this small area there are twenty cities, and twenty other towns have each a population of over five thousand.

Within the state there is great diversity of soil and climate. The waters of Long Island Sound exert an equalizing influence upon temperatures, so that along the coast, there are no such extreme high and low temperatures as are recorded inland. Though there are seldom tornadoes or blizzards, such as occur in the middle western states, there are constant and often abrupt changes in temperature. Mark Twain once remarked that there is no weather in New England—nothing but samples. Though the average rainfall is about 47 inches, there has been an excess of fully six inches the past season, interfering considerably with honey production.

Native vegetation and cultivated crops are as diversified as the climate. There are small forest areas and a large proportion of cut-over woodland, covered with brush. Farms are thickly scattered all over the state, and apple orchards are well distributed. In certain sections, peach growing, tobacco growing, truck crops, seed growing, floriculture, predominate—in fact, all lines of agriculture and horticulture suitable to the climate are carried on in Connecticut. There is also considerable so-called waste land with growth of wild plants, like sumac, which furnishes pasturage for bees.

Streams, lakes and reservoirs are sufficiently numerous and well distributed so that seemingly bees would never lack for water. Connecticut is, therefore, a fairly favorable place to make honey and markets are right at home.

Very little was known about the beekeeping industry in Connecticut prior to 1910, when the first inspections for bee diseases were made under the law enacted by the preceding legislature, though a state beekeepers' association had then been in existence for several years.

There are on file in my office the names of 2,571 beekeepers who own some 20,000 colonies of bees, but we have reason to believe that there are many more of which the inspectors never heard. I am sure that there are more than 3,000 beekeepers. One of the chief difficulties encountered by the inspectors is to learn who are keeping bees and where the apiaries are located. The Connecticut Beekeepers' Association originated a bill which was introduced into the last session of the legislature providing for the registration of beekeepers with the town clerk in each town where the bees are kept. This measure became a law in the following form:

SECTION 1. Every person owning one or more hives of bees shall, annually, on or before the first day of October, make application to the town clerk of the town in

which such bees are kept, for the registration of such bees, and such town clerk shall issue to such applicant a certificate of registration upon the payment of a recording fee of twenty-five cents, which certificate shall be in the form prescribed and upon blanks furnished by the commissioner of domestic animals and shall be recorded in the office of such town clerk.

Sec. 2. A record of such registration with the name and place of residence of the registrant and the definite location in the town where bees are kept by him shall be recorded in a separate book in the office of the town clerk, which records shall be accessible to the public.

Sec. 3. Any owner of bees who shall fail to register as required by the provisions of this act shall be fined not more than five dollars.

The winter of 1917–18 was very severe in Connecticut and many bees died. Some beekeepers lost all their colonies, others only a part. Not only were honey bees killed, but the native bees of *Andrena*, *Halictus* and allied genera are believed to have winter-killed as they were extremely scarce the first part of the summer of 1918. In addition to the scarcity of bees in orchard blooming time, the temperature was so low that the few bees surviving the winter could not work the flowers. Consequently, except in a few localities, there was a poor set of fruit, especially apples. The peach buds were nearly all killed anyway.

As the effect of the winter was so severe on bees, all beekeepers were urged to protect the hives during the following winter, 1918–19, which as you know, was very mild and bees would have wintered nicely without protection. Nevertheless, after the protective covers have once been made it costs very little to put them on and they should be applied every season as an insurance. It is always advisable to safeguard the welfare of each colony.

The inspection service was first established in 1910, and has been in effect just ten years. At first the inspections could be made only on complaint or request. Most interested beekeepers were willing to sign the papers to have their own apiary inspected; this defect in the law was remedied by the legislature of 1913, and since then the inspectors have had authority to inspect bees anywhere within the state without requests or complaints. The chief hindrance to the inspection work has been the small appropriation, but the last legislature has increased this to $2,000 annually.

It is interesting to note that when the first inspections were made in 1910, European foul brood was abundant everywhere, more than 75 per cent of the apiaries, and nearly 50 per cent of the colonies being infested. Though only a portion of the apiaries have been inspected each year, there has been a gradual decrease in European foul brood until 1919, when only 6.6 per cent of the apiaries and 1.2 per cent of the colonies were infested. Though it is possible that the disease has

diminished in virulence, this result, I believe, may be fairly attributed to the inspection service and particularly to the extension work done by the inspectors in showing the owners how to recognize the disease and how to eradicate it. The percentages for each are as follows:

PERCENTAGES OF EUROPEAN FOUL BROOD IN APIARIES INSPECTED

Year	No. apiaries inspected	No. colonies inspected	Percentage infested, Apiaries	European foul brood Colonies
1910	208	1,595	75.9	49.7
1911	162	1,571	51.8	27.4
1912	153	1,431	47.7	23.5
1913	189	1,500	44.4	24.5
1914	463	3,882	32.6	13.9
1915	494	4,241	26.1	10.3
1916	467	3,898	18.8	7 05
1917	473	4,506	16.7	4 86
1918	395	3,047	9.8	3.3
1919	723	6,070	6.6	1 2

The occurence of American foul brood has, of course, been sporadic. It has been mostly in the southern part of the state, and there was more of it in 1919 than in any year since the inspection service was inaugurated. The record of percentages for this disease for the ten-year period is as follows:

PERCENTAGES OF AMERICAN FOUL BROOD IN APIARIES INSPECTED

Year	No. apiaries inspected	No. colonies inspected	Percentage infested, Apiaries	American foul brood Colonies
1910	208	1,595	00	00
1911	162	1,571	00	00
1912	153	1,431	00	00
1913	189	1,500	00	00
1914	463	3,882	1.07	.7
1915	494	4,241	.8	.18
1916	467	3,898	1.07	.15
1917	473	4,506	.42	.17
1918	395	3,047	1.01	.32
1919	723	6,070	3.0	1.1

We now have an extension worker in apiculture in Connecticut. With the right kind of demonstrations, exhibits, and many personal visits to apiaries, I believe that the future is promising for the business. Possibly it may be necessary to cultivate or encourage sweet clover or some other valuable honey producing plant, but this will come about as a direct result of aroused interest in the subject, and intelligent management of apiaries.

The value of local organizations in stimulating interest should not be overlooked. A county association was organized in Fairfield County in October, 1918, and Professor Watson, who was then the extension worker with bees, told me that he should not be content until he saw a live organization of beekeepers in each county of the state. Professor Watson has since gone into the Bureau of Entomology, and his successor, Prof. L. B. Crandall, is just beginning his work in the state, and though I have not conferred with him on this point, I am certain from the tone of his paper prepared for this meeting that he will leave no stone unturned to promote the interests of beekeeping within the state.

I have mentioned these conditions in connection with my own state, but no doubt they are common to other states. The welfare of the business demands better beekeepers rather than more of them. With most beekeepers in Connecticut, the keeping of bees is not the chief business but is only a side issue. The few colonies in the average apiary are not enough to warrant a large outlay in time or equipment, and in many cases they do not receive proper treatment. It is believed that the registration of beekeepers, more money for inspection, and the right kind of extension work will make for more intelligent management, and prove a great benefit to the business as a whole.

Chairman W. E. Britton: We will now listen to a paper by Mr. Frank C. Pellett.

Mr. F. C. Pellett: It was accident rather than intention that two subjects were assigned to me on the program. I shall present only one. I might say, incidentally, that Boys' and Girls' Bee Clubs was a subject I chose last year, and I expected to give an outline of some of the things I had observed in localities where such clubs existed. In Kansas, where a demonstration agent introduced this, especially in the localities where there were no commercial beekeepers, he required parents of each boy or girl who became a member to have bees and they were also required to furnish the club member with the proper equipment for transferring them. One thing especially which attracted my attention was the fact that one farmer made a good deal of fun of one of these boys for taking up these newfangled notions. In the fall of the year, the boy had more honey to sell from his two cells than the farmer had from fifty. The boys' work prospered in that locality from that time on.

My paper is entitled "Adapting System to Locality."

ADAPTING SYSTEM TO LOCALITY

By Frank C. Pellett

Locality is a badly overworked word in our beekeeping literature.

It is too often used to explain away differences of opinion due to careless observation or improper manipulation. While differences in bee behavior are not usually to be credited to locality, a different system of manipulation is often necessary to make the most of the flows arising under different conditions.

Doctor Phillips and his staff have brought forcibly to the attention of the beekeepers, through the medium of the short courses recently so popular, that the fundamentals of beekeeping are few and easily grasped by the intelligent mind. Room, stores and protection have been shown to constitute the essentials which must be recognized under any conditions. With a proper understanding of these, it then becomes important that the beekeeper study his individual location in order that he may apply his knowledge to bringing his colonies to the peak of brood rearing in time for the principal harvest of the year. In this connection a brief consideration of the peculiar conditions to be met in different parts of the country and the effect upon the plans of the beekeeper may be of some interest.

In southwest Iowa, where the writer kept bees for several years, there was but one principal honey-flow—from white clover. This flow lasted from ten days to six weeks. If the bees were not ready when the flow came there was little chance of securing a crop from a later flow. Usually there was sufficient fall flow to fill the hives and put the bees into good condition for winter, but no surplus worth while was secured. In a location like that the beekeeper must bend every energy of the entire year to bring his bees to maximum strength at the beginning of June and to prevent swarming till the brief flow is over. If the bees winter poorly there is little time for coddling them and building up weaklings to profitable strength. Good wintering is essential. It is also important that no time be lost in building up the colonies in spring. It was found that, by wintering the colonies in two stories with the upper brood-chamber well filled with honey, it was usually possible to turn the surplus of food into young bees and have the two stories well filled with brood and bees by the close of fruit bloom, always providing that the bees wintered well. With careful attention it was possible to get from two to four times as much surplus as the average farmer with bees in the neighborhood was able to secure. There was seldom a season when it was possible to make increase ahead of the honey-flow to any extent, without reducing the crop.

In contrast to this location there are places in the alfalfa districts of Colorado where the main flow comes in August, where it is the practice to make increase from the early flows and still have the bees in good condition for the principal flow. There, some beekeepers practice wintering in two stories and, as soon as the two stories are filled with

brood in spring, the upper story is removed and given a ripe queen cell. With the late flow it is possible to have two colonies instead of one for the gathering of the crop. In a situation of this kind, poor wintering is not nearly as disastrous,—providing, of course, that the bees come through alive,—as it is where there is only one flow and that very early.

In the vicinity of Washington, D. C., tulip-tree, often spoken of as "poplar," is the principal source. Because it blooms so early that the bees are seldom ready for the flow, the vicinity is generally regarded as a poor location for beekeeping. Yet an average of something like 100 pounds of surplus honey per colony is gathered at the government apiary where careful wintering is practiced.

In the lower Rio Grande Valley of Texas there are frequent flows from many sources. These flows are likely to come at almost any time after a rain. Heavy flows are infrequent and, light flows coming so often, it is difficult for the beekeeper to harvest much surplus, since the honey is largely consumed in the almost continuous brood-rearing. The writer found the bees to be very strong in well-kept apiaries in early March. There were reports, also, that bees sometimes swarmed as late as December and found sufficient support to carry them through. In a location like this, commercial honey production is less profitable than the production of bees and queens to supply the demand of northern beekeepers. In north Texas, at Waxahachie, local beekeepers report that the bees are ready for business by April, yet the main flow does not come till June. They find it very difficult to keep down swarming during the intervening period. One man, T. W. Burleson, has solved this problem by selling his early bees in packages and still giving his colonies time to build up for the honey-flow from cotton. Until the demand for bees developed he found great difficulty in overcoming the swarming problem.

In such locations beekeepers often are very indifferent about giving attention to wintering. They say that no matter how weak the bees are in spring, there is still time to build up in time for the flow and that strong colonies in early spring are of no particular advantage.

There are other factors beside the time of the honey-flow that enter into the consideration of locality. The source and nature of the flows also determine to a great extent the system which is best suited to the conditions. Comb-honey cannot be produced to advantage except under specially favorable conditions. A slow or intermittent flow will result in poorly finished sections and a short crop, where a good crop of extracted honey might be secured. In some sections of Colorado there is much gum-weed (*Grindelia squarrosa*), which granulates very quickly, sometimes even before the honey is sealed. Where this honey is mixed with the alfalfa, granulation is sure to follow within

a short time and as a result the comb-honey market gets a black eye. Granulated comb-honey is a drug on the market and in such a situation extracted honey only should be produced. At least comb-honey supers should be replaced with extracting supers during the flow from gum-weed. Enough of this gum-weed alfalfa mixture has gone to eastern markets to create a prejudice against Colorado comb-honey in some places.

In several of the southern states, bitterweed (*Helenium tenuifolium*) is quite common. The honey is absolutely unpalatable and should never be placed on the market. Even a small quantity of this bitter honey is sufficient to spoil a whole tankful of good honey. There the beekeeper should remove all the good honey from the hive when the bees begin to work on bitterweed and give them empty supers of extracting combs. When the flow is over, if other flows are still to come, the bitter honey can be taken off and the other supers replaced. When the season is over, the bitter honey can be given back to the bees for winter stores. No adverse reports have been found from the use of bitter honey for wintering the bees.

The available pasturage determines the number of colonies that may be successfully kept in one yard and this in turn influences the system of management. In north Georgia there is a large area where not more than twenty-five colonies are profitable in one apiary. There is a variety of sources of nectar available but not enough of anything to support a large number of colonies. One beekeeper in that region keeps 800 colonies of bees, in thirty yards. This requires a large amount of travel, but his returns are more nearly constant than in any other locality with which I am familiar. In contrast there are numerous locations in the sweet clover districts and some in the buckwheat regions where three hundred or more colonies do well in one location.

The presence or absence of a supply of pollen for brood-rearing is also an important factor. In some places, where there are heavy flows, pollen is scarce and the beekeepers find it necessary to take the bees elsewhere to build up. This requires long distance moving which is tiresome and expensive.

The dependability of the forage is also to be considered. There are many places where good crops can be gathered occasionally, with frequent seasons of failure. This necessitates migratory beekeeping if the apiarist is to harvest a crop every year. There are numerous California beekeepers who make long moves from once to three or four times in a season, moving to such locations as promise an immediate harvest. This is practiced to a lesser extent in some of the central and eastern states. The Dadants find it frequently to their advantage to move their apiaries to the lowlands along the Mississippi River

when the crop is a failure on the uplands. This requires a move of something like thirty miles, which can easily be accomplished in a day, with their big trucks.

The above examples could be multiplied indefinitely, but are sufficient to show how necessary it is that the beekeeper be fully informed as to the conditions peculiar to his location and that he develop a system of beekeeping best adapted to those conditions.

CHAIRMAN W. E. BRITTON: If there is no discussion, we will take up the next paper, "The Relation of Bees to Fire-Blight," by H. A. Gossard. (Withdrawn for publication elsewhere.)

CHAIRMAN W. E. BRITTON: We will now listen to the paper by Professor J. H. Merrill, entitled "Preliminary Notes on the Value of Winter Protection of Bees," which will be read by Mr. M. C. Tanquary.

MR. M. C. TANQUARY: I am very sorry that Mr. Merrill is not here, because he has spent two years of work on this subject. I have tried to follow him more or less closely, as I was much interested in his work.

PRELIMINARY NOTES ON THE VALUE OF WINTER PROTECTION FOR BEES[1]

By J. H. MERRILL, *Apiarist, Kansas State Agricultural College and Experiment Station*

That a strong colony of bees will gather more honey than a weak one is a fact accepted by all experienced beekeepers. However, to gather more honey, this colony should be strong at the proper time in order to take the fullest advantage of the honey-flow. The proper time to have a colony strong is at the beginning of the honey-flow. If it becomes strong too early, it consumes stores which the bees have in the hive; if too late, it cannot assist in gathering the crop for that season. Whether or not the colony is strong will depend to a large extent upon how it passed through the winter.

Gates, 1914, gives some very valuable data on the temperature of the colony of bees throughout the year. Phillips and Demuth, 1914, give the results of some very careful observations on the temperature of a colony of bees in winter, and further explain in detail the actions of such a colony during the winter which are necessary in order to maintain a proper temperature. Phillips maintains that a bee may be compared to a storage battery in that it has a certain amount of energy to spend, after which it dies. He further says that the bee is

[1] Contribution No. 48 from the Entomological Laboratory, Kansas State Agricultural College. This paper embodies some of the results obtained in the prosecution of project No. 126 of the Agricultural Experiment Station.

obliged to resort to muscular activities in order to maintain the proper hive temperature. A system of winter protection which would minimize this expenditure of energy would result in a strong colony in the spring.

Phillips and Demuth, 1915 and 1918, give directions for preparing bees for the winter which will aid very materially in securing a strong colony of bees at the right time of the year. Although their explanations as to the need of winter protection for bees, and how to secure this should be satisfactory to all, there still remain a large number of people who either through mistaken observations of their own, prejudice, or on account of giving value to mistaken observations of others, will persist in refusing to accept even the clearest explanation if it does not happen to coincide with their preconceived opinions. This latter class of people are prone to maintain that these explanations may perhaps be facts, but they apply to some other part of the country than the one in which they reside. In order to convince them that these facts apply to their locality as well as to all other localities, and that these problems apply in every respect to them as much as to other beekeepers, it is often necessary to conduct additional experiments to prove further something which has been clearly explained before.

It has been the purpose of this experiment to gather data along the following points:

First, the comparative value of one-story and two-story hives for wintering; second, the importance of a windbreak; third, the comparative value of packed and unpacked hives for wintering; fourth, the amount of stores needed to last a colony until the honey-flow commences; fifth, the effect of climatic conditions on wintering; sixth, to ascertain what form of winter protection will insure the strongest colony of bees at the beginning of the honey-flow.

In order to secure data on these points, experiments have been carried on at the Kansas State Agricultural College since 1917. In the experiment, two sets of hives are used. One set is placed in an open exposed situation where it receives no protection at all from the prevailing winds, and the other set is placed in a very dense hedge windbreak, so that the strength of the wind is very materially broken before it reaches the hives. In each set there are three colonies of bees corresponding in every way with each other. That is, there is one one-story hive, one two-story hive, and one packed hive in each set. The packed hive is in a single packing case, with four inches of leaves beneath it, six inches around it, and eight inches on top, used as an insulation. The entrances during the winter months are contracted to one three-eighths of an inch auger hole. Each one of these six hives rests on a platform scale, and is not removed from its position throughout

the year. Daily readings are taken throughout the year of the weights of the various hives, and all changes in weight recorded each day. In order to determine the amount of honey that is in each hive, and the number of bees present, a general weighing of the colonies is made in the fall on the date that the bees are put into winter quarters. On the day that the honey-flow starts, another general weighing is made, to determine the number of bees which have passed through the winter and results of both the spring and the fall weighing are compared to secure the data desired. Briefly, the method of weighing is as follows:

Each colony is weighed early in the morning before any of the bees emerge. Next the weight of the hives without the frames is ascertained, and the weight of the frames with honey. From the weight of the frames of honey is deducted the weight of the empty frames, giving the amount of honey which is in the colony. We then know the weight of the hive, and also the combined weight of the hive and honey. This total, when subtracted from the weight of the hive, honey, and bees, gives the weight of the bees. Precautions are taken in recording these weights to prevent the bees from filling up with honey, thus making, according to the figures, a larger number of bees and smaller amount of honey than really exists in the hive. The process of weighing these colonies is rather complicated, usually requiring from three to four persons a whole day in order to weigh the six colonies in the experiment.

The number of bees in a pound has been variously estimated, but for the purpose of this experiment we assume that there are 5,000 bees in every pound. If this number is adhered to throughout the experiment, it will be as fair to one colony as to another. As stated above, the weight is recorded each day from each one of these hives throughout the year. In addition to these, the record of the temperature, the direction of the wind, and the strength of the wind for each day is also recorded in order that we may have an opportunity to learn what effect climatic changes have on the wintering of the bees. These colonies are brought as nearly as possible up to the same strength in bees and honey. The queens used in them are all from the same stock, purchased from a reliable queen breeder, and introduced into the colonies on the same day. Each colony is requeened during the month of August in order to insure a young queen to carry on the duty of the hive. The weighing which is conducted in the spring shows whether or not there has been an increase in the number of bees during the winter. It is considered that the form of wintering which produces the largest number of bees in the hive on the day that the honey-flow starts is the most successful method of wintering.

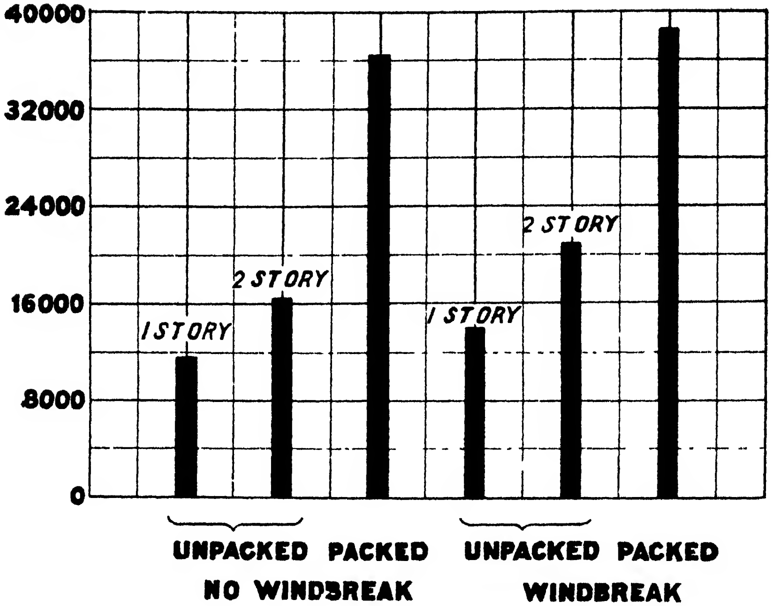


Fig. 1. Showing the number of bees at the beginning of the honey-flow, the advantage of packed over unpacked hives, and the value of sheltering with a windbreak.

TABLE I. NUMBER OF BEES AND FRAMES OF BROOD IN EACH COLONY MAY 4, 1919

	Unsheltered—No Windbreak	
One-story	Two-story	Packed
11,718—3 2/3 frames	16,406—3 1/2 frames	36,718 —4 1/2 frames
	Sheltered—Windbreak	
One-story	Two-story	Packed
14,063—4 1/2 frames	20,936—3 3/4 frames	38,594—5 3/4 frames

COMPARATIVE VALUE OF ONE-STORY AND TWO-STORY HIVES

At first glance it would seem that bees would winter better in a one-story hive than they would in a two-story hive, since there is less space to keep warm, and consequently, they would not use as much energy as they would in a two-story hive. If the winter stores are properly arranged so that the bees will be in the upper hive body during the coldest part of the winter, the objection of extra room to be kept warm is largely overcome. Two of the requirements for good wintering, according to Phillips and Demuth, 1915, are, first, plenty of stores, and second, plenty of room for brood rearing. A two-story hive suits these conditions much better than a one-story hive would do.

Table I shows that in the spring the two-story hive in the open had 16,406 bees, while the one-story hive had only 11,718, or a difference of 5,688 bees. In the windbreak, the two-story hive had 20,936 bees and the one-story hive had 14,063, or a difference of 6,873 bees. This

shows not only the superiority of the two-story hive over the one-story, but also shows that the windbreak made a difference of 1,185 bees.

TABLE II. COMPARISON BETWEEN NUMBER OF BEES IN FALL AND SPRING WEIGHINGS

	1917–18	1918–19
No Windbreak		
One-story	−332	−3,282
Two-story	2,808	−469
Packed	4,576	22,968
Windbreak		
One-story	4,538	313
Two-story	13,346	5,936
Packed	15,132	24,844

In 1917, the average daily consumption of honey for the six hives, over a period of 139 days, was one eighth of a pound.

In 1918, the average daily consumption of honey for the six hives, over a period of 150 days, was one eighth of a pound.

Table II shows that in the winter of 1917–18, while the one-story hive in the open lost 332 bees during the winter, the two-story hive similarly placed gained 2,208 bees. With those bees protected by the windbreak the two-story hive gained 13,346, while the one-story hive gained only 4,538. During the winter of 1918–19 the one-story hive in the open lost 3,282 bees, while the two-story hive only lost 469. In the windbreak the two-story hive gained 5,936, while the one-story hive gained only 313.

If the number of bees at the beginning of the honey-flow be a proper standard, these results plainly indicate the superiority of the two-story hive. The same factors which make this possible ought to make the deeper and larger hives superior even to the two-story hive, since the latter will have plenty of room for stores and ample room for spring brood rearing without too large a space for the bees to keep warm.

COMPARATIVE VALUE OF A WINDBREAK

A study of Table I would indicate the value of a windbreak, especially to colonies which are not otherwise protected. In the case of the one-story hive, there were 2,345 more bees in the hive protected by a windbreak than in the unprotected one-story hive. The protected two-story hive had 4,530 more bees than the unprotected two-story hive. While the protected packed hive only had 1,776 more bees than the unprotected packed hive, thus indicating that although a windbreak is very valuable, yet if it is not possible to provide one the loss may be partially overcome by using sufficient packing. The figures shown in Table II also indicate very clearly the value of a windbreak. In 1917–18 the one-story hive lost 332 bees during the winter, while the one-story hive in the sheltered position gained 4,538. During the next winter, the same hives respectively lost 3,282 and gained 313. The two-story hive shows the value of a windbreak more clearly even

than the one-story, because while the two-story unsheltered hive gained 2,808 in 1917–18, the sheltered hive gained 13,346. In 1918–

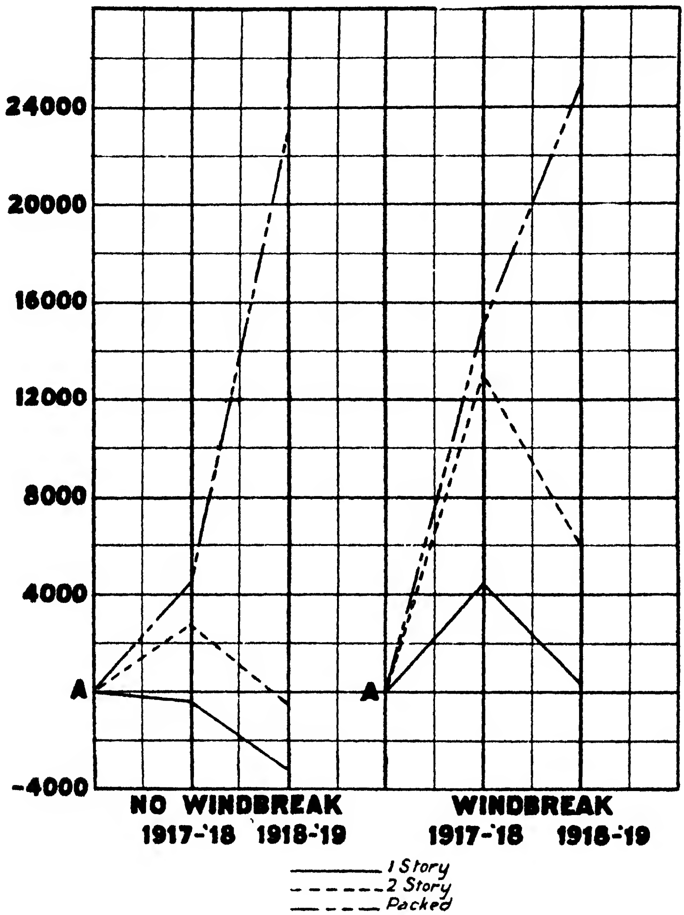


Fig. 2. Showing the gain or loss in the number of bees between the fall and spring weighings, demonstrating the value of both packing and windbreak.

19 the first hive lost 469 while the second gained 5,936. Judged by the standard already adopted, the windbreak is shown to be very valuable as a factor of winter protection.

Comparative Value of Packed and Unpacked Hives for Winter

During the winter of 1917–18, the packed hives were insulated with shavings and excelsior for packing material, but it was not as good as the forest-tree leaves which were used in 1918–19, and which will be used in the future.

Table I shows that the packed hive had 25,000 more bees than the one-story unpacked hive. This represents about five pounds of bees, which, at their present market value of around $2 a pound, would mean about $10. The difference between the number of bees in a packed hive and in an unpacked one in the sheltered set of hives was practically the same as in the open.

Table II, which gives the results for 1918–19, shows that the winter of 1918–19 was harder on the bees than was the preceding winter, and yet this is the winter in which packed bees wintered the best. In fact, there is more difference in this unfavorable winter between the packed and unpacked hives than in the more favorable one. This is shown by the fact that while the one-story hive in the open lost 3,282 bees, and the two-story hive 469, the packed hive gained 22,968. In the sheltered hives the one-story hive gained 313 bees, the two-story hive gained 593,

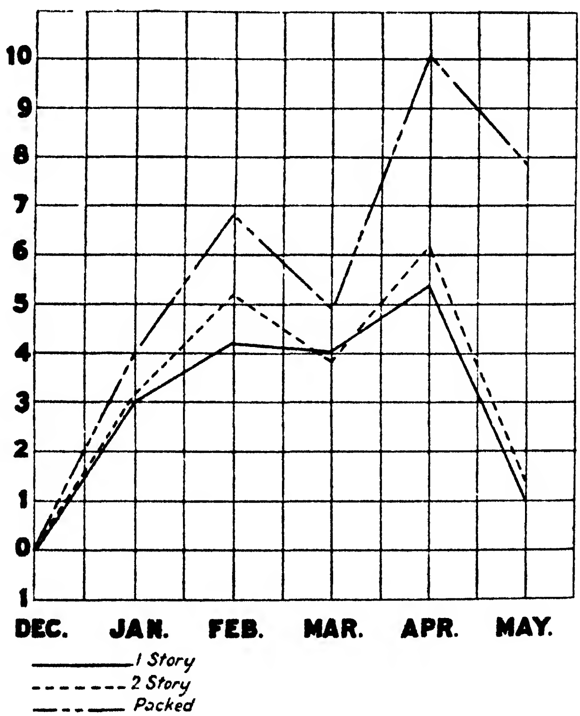


Fig. 3. A comparison of the amount of stores consumed each month by colonies in packed hives and the amount consumed by colonies in unpacked hives.

but the packed hive gained 24,844. When judged by the standard of the number of bees in the hive, packing appears to be the most valuable factor of wintering, excepting, of course, sufficient stores.

THE AMOUNT OF STORES NECESSARY TO LAST A COLONY UNTIL THE BEGINNING OF THE HONEY-FLOW

The amount of stores necessary to last a colony until the honey-flow begins will depend largely upon the size of the colony, size of the hive, and upon the amount of protection which it has.

Figure III represents, graphically, the amount of stores consumed by the bees in each kind of hive throughout the winter. As will be seen in an examination of this figure, the colonies in the one-story hive consumed less stores than any of the others, while the colonies in the packed hives consumed the most. This difference is especially noticeable during the month of March at which time the stores were being used for brood rearing. A comparison between Figure I and Figure III will show a direct relation between the amount of stores consumed and the number of bees present in each colony at the beginning of the honey-flow.

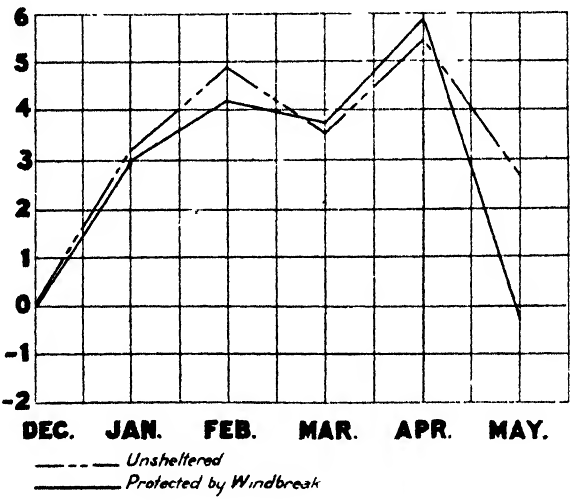


Fig. 4. A comparison of the number of pounds of stores consumed by colonies that are not sheltered with the amount consumed by colonies that are sheltered by a windbreak.

Figure IV represents a comparison of the amount of honey consumed by colonies wintered in the open, and those sheltered by a windbreak. The sheltered colonies consumed less during December, January, and February, but during March they used more than the unprotected colonies. During April they used less stores, or rather did not lose as much in weight, owing to the fact that brood rearing had continued for some time, and since it was greater in the sheltered colonies, the presence of the new bees, and what honey could be gathered at that time account for the fact that they gained weight during that month.

A study of this figure will show that during the months of December, January, and February, when stores were being consumed only to maintain the life of the bees that were already in the hive, those which were in sheltered positions did not consume as much honey as those in the open. However, during the month of March they consumed so much more honey than did the other coloniês that the total amount consumed was about equal in both cases, the difference being that the colonies in the sheltered positions consumed their greater amount of stores for the purpose of brood rearing. Had weights been taken only at the beginning and end of these periods, the fact that the unsheltered hives consumed more at one time than the sheltered, and less at another, would not have been noticed.

TABLE III. MONTHLY CHANGE IN WEIGHTS

In the upper column for each month are placed those colonies protected by a windbreak and in the lower those not protected. Unless otherwise stated, the figures given represent a loss in pounds of weight.

One-story	*Two-story*	*Packed hive*
	December, 1918, to January, 1919	
2 6/8	3 2/8	3 4/8
3 2/8	3	4 2/8
	January, 1919, to February, 1919	
3 5/8	5 1/8	5 4/8
4 6/8	5 2/8	8 1/8
	February, 1919, to March, 1919	
4 1/8	3 4/8	5 4/8
3 7/8	3 3/8	4 3/8
	March, 1919, to April, 1919	
6 2/8	5 5/8	10 7/8
4 3/8	6 5/8	9 2/8
	April, 1919, to May, 1919	
4/8 gain	1 8 gain	4 1/8
2 5/8	2 5/8	11 5/8
	Total for 151 days	
16 2/8	17 3/8	24 4/8
18 7/8	20 7/8	37 5/8
	Average Daily Consumption	
1 6 oz.	1 8 oz.	2.6 oz.
2. oz.	2 2 oz.	3 9 oz.

Table III shows that the total amount of stores consumed for a period of 151 days was less for the one-story hive in the open, being 16 2/8 pounds, and greatest for the packed hive in the sheltered position. Reference to Figure I will show that the number of bees in the spring is proportional to the amount of stores consumed. The one-story unpacked hive lost 3,282 between fall and spring, while the packed hive gained 24,844. The difference between the sheltered and unsheltered colonies, as regards daily consumption, was 4/10 of an ounce for the one-story hives, 4/10 of an ounce for the two-story hives, and 1 3/10 ounces for the packed hives. It has been shown that less honey will be required to winter bees in a one-story hive than in either the two-story or packed hive; that less will be required in a two-story

hive than in the packed hive, and in each case less stores will be consumed where the bees are not protected by a windbreak than would be the case if they are protected, but the number of bees in the colony at the beginning of the honey-flow is directly proportionate to the amount of stores consumed by that colony during the winter.

THE EFFECT OF CLIMATIC CONDITIONS ON WINTERING

One of the arguments most commonly made against using winter protection is that the bees in some particular locality may not need any winter protection because that locality has such open winters.

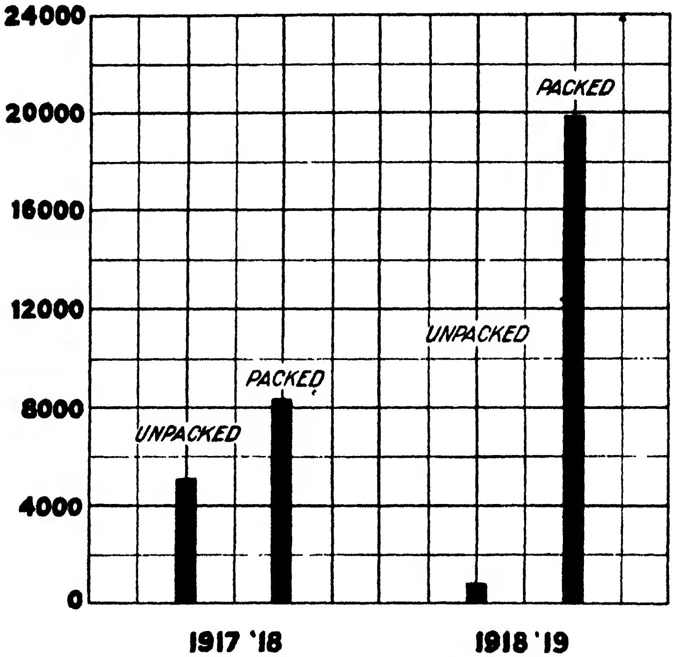


Fig. 5. Shows the average gain in number of bees in packed and unpacked hives during a severe winter with long periods of cold weather and the gain or loss in the same colonies during an open winter with shorter periods of cold weather.

Figure V represents, graphically, the effects of both a severe winter and an open winter upon the number of bees to be found in the colony in the spring. In the winter of 1917–18, which was very severe, bees were confined to their hives for long periods at a time, while the winter of 1918–19 was an open winter with no long periods of cold weather.

Figure V plainly shows which winter was the more favorable for the successful wintering of bees. During the severe winter of 1917–18, the one-story hive in the open lost 332, while during the open winter

of 1918–19 the same hive lost 3,282. During the severe winter, the two-story unprotected colony gained 2,808, while during the open winter this same colony lost 469. During the severe winter, the one-story colony, protected by a windbreak, gained 4,538, while in the open winter the same colony gained only 313. The two-story hive, protected by a windbreak, gained 13,346 bees during the severe winter, but only 5,936 during the open winter. However, the effect of climatic conditions is much more noticeable on the unpacked colonies than on the packed ones. The insulation which is placed around the hives protects the bees from any sudden changes of weather. If the warm sun beats upon unpacked colonies it soon causes a considerable rise in temperature within the hive. However, with a well insulated colony this would not be the case. Although the unpacked hives did not do as well during the open winter as they did during the severe winter, yet the packed hives did even better, owing to the fact, as explained before, that they were packed with leaves, which is a better insulating material than that which was used the previous winter. While one colony in the open was losing 3,282 bees, the packed hive in the open during this open winter gained 22,968, but in the windbreak, while the one-story unpacked hive gained 313, the packed hive gained 24,844.

The figure above, and the data which accompany it, plainly indicates that a severe winter, with long periods of cold weather, is really much more favorable than is the open winter with shorter periods of cold weather.

Form of Winter Protection Which Will Insure the Strongest Colony of Bees at the Beginning of the Honey-Flow

Reference to the figures given above would show that the two-story hive has advantages over the one-story hive, and also that probably for the same reason a large hive would be equally as good, if not better, than the two-story hive, and also that a well packed colony is greatly to be desired over an unpacked colony. The difference in the number of bees in the unpacked and packed hives is sufficiently great to more than repay the expense which a beekeeper may be put to in providing sufficient packing. In order to know the amount of stores to leave in the hive, the beekeeper must take into consideration the type of hive he is going to use. If it is a one-story to be used with no packing, he should leave at least 20 pounds of stores, as this would usually carry the bees through until the beginning of the honey-flow. However, 25 pounds would be a safer amount. If he is going to winter his bees in a two-story unprotected hive, then he had better leave 25 to 30 pounds, preferably 30 pounds. If, however, he is going to pack them he should leave enough stores to last well into the spring, as he will not need to

molest them during the early spring. For this reason he should leave 40 to 50 pounds. While ordinarily they would pass the winter well on 40 pounds, it would be better to have the 50 pounds in there for safety.

The value of a windbreak has been clearly shown, and as explained by Phillips and Demuth, this should consist of a broken windbreak, such as a hedge, or if a fence must be used, it should be so constructed that there will be large cracks between the boards. To sum up the whole thing: a packed hive sheltered from the wind by a good windbreak, having 45 or 50 pounds of stores, has the best chance of passing the winter successfully, and will probably contain the largest number of bees in the spring at the beginning of the honey-flow ready to take advantage of the same.

Summary

First. Directions have been given in previous publications as to the method for giving bees winter protection. The purpose of this work is to secure data showing the necessity of using this winter protection.

Second. Six hives containing a known amount of honey and a known number of bees were placed on scales, and daily readings taken of all changes in weight.

Third. Three of these hives were sheltered by a windbreak while the others were not.

Fourth. Each set of three consisted of one one-story hive, one two-story hive, and one packed hive.

Fifth. In addition to making daily readings of the changes in weights, a general weighing was made at the beginning of the honey-flow in the spring to determine the number of bees in the colonies on that date.

Sixth. These observations show that the two-story hive is preferable to the one-story hive, and the packed hive is much to be preferred over the unpacked hive.

Seventh. It was also shown that a windbreak is very essential, especially to colonies which have no other form of winter protection.

Eighth. The effect of a severe winter was found to be less injurious to the over-wintering of bees than an open winter.

Ninth. Colonies which are packed for the winter consume more stores, owing to the fact that more stores are necessary, due to increased brood rearing.

Literature Cited

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1915. Outdoor Wintering of Bees. Bul. No. 695, U. S. Dept. of Agri.

1918. The Preparation of Bees for Outdoor Wintering. Bul. No. 1012, U. S. Dept. of Agri.

GATES, B. N.

1914. The Temperature of the Bee Colony. Bul. No. 96, U. S. Dept. of Agri.

MR. G. M. BENTLEY: We have a great deal of trouble with the wintering of bees in Tennessee. We are sorry that Dr. Merrill is not with us to explain more concerning his methods. In Tennessee we have found it very difficult to interest people in the winter protection of bees, simply because we frequently have open winters. When Mr. C. E. Bartholomew was in Tennessee doing extension work in beekeeping, he patterned a winter hive, an enclosure, after that of Dr. Phillips, which included four hives with four entrances. That method of winter protection was pretty generally introduced, but the greatest trouble was that many beekeepers thought that nature had given them plenty of protection simply because the winters were not severe. With the experimental apiary at the Experiment Station we have found that sudden changes are the causes that have developed the dwindling or weak colonies of bees in the spring, often making them too weak to overcome that trouble. We have some concrete examples in the station apiary and in different parts of the state where persons who carefully pack their bees in the winter receive a yield of 110 and sometimes 200 pounds of comb honey per hive. The average production for the state of Tennessee is 39½ pounds, counting the log gum, the box hive, and the ordinary modern hive. Without any doubt winter packing in the southern states is a success.

MR. G. G. AINSLIE: Didn't I understand that the packed hive is a one-story or two-story hive?

MR. M. C. TANQUARY: A packed hive is only a single-story hive.

CHAIRMAN W. E. BRITTON: The next on the program is a three-reel motion picture illustrating beekeeping in the Californian National Forest. These reels have been furnished by Mr. George A. Coleman.

CHAIRMAN W. E. BRITTON: We will now listen to the report of the committee on nominations, consisting of Messrs. J. G. Sanders, E. C. Cotton and G. G. Ainslie.

MR. J. G. SANDERS: The Committee on Nominations presents the name of Mr. F. B. Paddock for Chairman and Mr. G. M. Bentley for Secretary for the ensuing year.

It was voted that the report of the committee be accepted and the recommendations adopted.

The above-mentioned members were declared elected and the session adjourned.

Morning Session, Thursday, January 1, 1920, 10.15 a. m.

PRESIDENT W. C. O'KANE: The chair desires to wish all of you a Very Happy New Year.

The first paper on the program is "The Work of the Railroad Entomologist," by V. I. Safro.

THE WORK OF THE RAILROAD ENTOMOLOGIST

By V. I. SAFRO, *Louisville, Ky.*

With the development of railroad agricultural departments, the need for railroad entomologists is coming more and more into evidence and it will be but a matter of a few years before every large railroad will have its entomological officials. There is a definite field in the agricultural and commercial activities of a large railroad which would come naturally under the jurisdiction of the entomologist—work which now is either entirely neglected or to a great extent imperfectly conducted. The intent of this article is to indicate to prospective railroad entomologists the lines of work that should come under their attention, and, incidentally, to crystallize for railroad agriculturists the duties that definitely necessitate the employment of entomologists.

The writer has based his discussion upon considerable work done for and with railroads, upon some five years of frequent contact with railroad entomologists, horticulturists, agriculturists, and their problems, and upon many excellent opportunities to observe the need of such work as is here indicated.

The occurrence and solution of certain entomological problems has been noticed from time to time in its most evident form; namely, the reduction of tonnage due to insect damage to crops. And whereas this is by no means the only line of endeavor for the railroad entomologist, it is the one line that the average railroad official can understand without the exhaustive explanation that may be necessary to justify the appointment of an entomologist for the solution of other entomological problems affecting railroad economics.

In instances that have come before the writer, the solution of any one of many of these common tonnage problems would of itself have paid the salary of the entomologist several times over and given a handsome profit to the railroad, and this is what the railroad official in authority will most easily understand.

POSSIBILITIES OF INCREASED TONNAGE

The writer has at hand a letter received some time ago from J. A. Hughes, horticulturist, American Refrigerator Transit Co., Missouri Pacific Railroad. He states:

"We are prepared to move about 3,000 cars of onions from southern Texas, and the Laredo district is suffering from one of the worst infestations of thrips I have ever seen. . . . We estimate the tonnage reduced fully 20 per cent on account of this pest."

It had previously been demonstrated in this same district that the ravages of the onion thrips could be materially checked by proper control methods; and, accepting Mr. Hughes's estimate of 20 per cent reduction in tonnage due to the onion thrips, the work of an entomologist for about two months in the Laredo district might have been conducive to a greater tonnage with a maximum possibility of increase amounting to 750 cars.

E. G. Kelly writes in the JOURNAL OF ECONOMIC ENTOMOLOGY, April, 1917, p. 233, that the "green bug" in 1916 destroyed 250,000 acres of oats and 100,000 acres of wheat in Kansas alone, mostly in only four counties. In Oklahoma, the destruction was estimated at 350,000 acres of oats and 160,000 acres of wheat. Mr. Kelly informed the writer at the time that a good part of this infestation could have been prevented by proper entomological procedure.

Proper entomological work at that time would not only have paid the railroad a profit amounting to many times the expenditure of the entomological service but would have increased the wealth of the population along the railroad and because of this would have materially contributed to the good will—an asset which the railroads recognize as being of exceeding importance.

The destruction of potatoes by the Colorado potato beetle is one of the very common examples. Within the last several years destruction of crops by the potato aphis has become evident, so much so that several railroads have endeavored to interest themselves to the extent of seeking relief for the growers of their respective districts.

The University of California, as a result of work on the peach worm at Newcastle, Cal., produced in one year an increase of 500 cars of peaches, as reported by the local railroad officials. After eight years of work at Watsonville, Cal., the tonnage of apples was increased to the amount of over 800 cars. Upon the completion of mosquito extermination work at Bakersville, Cal., land values increased 200 per cent.

The past season at Midland, Tex., arrangements were made to take care of the crop of honey dew melons. One hundred refrigerator cars, and sufficient ice accordingly, were reserved for the purpose. An epidemic of aphis occurred, found the growers unprepared and unequipped to meet it, with the result that the tonnage was reduced to only four cars. Here was a loss of tonnage, a loss of ice, ninety-six cars tied up when refrigerator cars were in demand elsewhere, a loss of revenue to the railroad and the refrigerator company of $150 per car.

The writer's definite results in increasing cantaloupe tonnage in southern California through control of severe aphis epidemics, leads him to state that practically all this tonnage could have been saved—an item amounting in transportation charges alone to about $14,400, to say nothing of loss to the growers in the section; and, in consequence, their lower purchasing powers and smaller shipments of purchases into the district.

These few random examples give a definite glimpse of possibilities.

Epidemics of grasshoppers, Colorado potato beetles, chinch bugs, etc., are too well known to merit further discussion here.

The cry of the roads is for tonnage, tonnage and more tonnage. Give them tonnage and they can use you whether you call yourself a freight solicitor or an entomologist.

Entomological Assistance and Crop Diversification

Crop diversification is an important item in railroad economics. The greater the diversification—within, of course, reasonable limits—the greater the economy effected in the distribution of rolling stock, labor and risks. A section devoted entirely to one crop may cause a railroad enormous loss by the failure of that crop. Diversification would tend to minimize the possibilities of total crop failures. Single crop districts give rise to freight congestions, shortages of cars, and embargoes—all of which problems can be minimized by proper diversification.

In many instances observed by the writer, the limiting factor preventing diversification has been an insect factor susceptible to satisfactory solution.

Several instances have come to the writer's attention in which some crops are grown only on a household scale which should be grown commercially in the same district. Such is often the case with cabbages, onions, melons and other truck crops. Entomological work in such instances may result in practically building up communities.

Often it occurs that crops, once established, are later abandoned because of insect pests.

Doctor E. D. Ball, in a letter to the writer dated April 16, 1917, stated that:

"'Sugar beet blight,' caused by the puncture of the beet leaf-hopper, has been a very largely contributing cause of the abandonment of sugar beet raising in a number of western areas. Several factories have been dismantled and others are lying idle at the present time on this account, involving losses running into the millions of dollars in each case. These losses, while not entirely preventable in most cases, were sufficiently so to have maintained the industry if entomological assistance had been used."

He also states:

"The sugar beet seed production was abandoned in the Arkansas Valley and other

districts of the Plains region on account of injury by the false chinch bug, an injury which might have been controlled by entomological assistance."

Doctor F. H. Chittenden, in a letter to the writer April 14, 1917, stated:

"The raising of seed beets has been practically abandoned in the east on account of the ravages in past times of the beet aphis"

The Imperial Valley, California, at one time had a distinct cabbage shipping season. Primarily because of the cabbage aphis and the lack of information among the growers on proper methods of control, the growing of cabbage on a large scale was at one time practically abandoned and even to the present time the production of Imperial Valley cabbages is much smaller than it would be under proper stimulation.

Coöperation Between Railroad and Grower and Other Agencies

The railroads recognize this item as being of considerable, often in fact of paramount, importance. Practically all railroads endeavor in some form, often very crudely and ineffectively, to foster such coöperation. Railroads have reprinted official bulletins or issued publications of their own, intended to disseminate the proper information not only to growers themselves but to business men, local banks, etc.

Railroad demonstration trains are of common occurrence and as this phase of agricultural activity becomes better known, the entomological work incident to such trains and railroad schools will become quite evident.

One example of this type of service will suffice: At one time the M. K. and T. Railroad sent out a notice to orchardists along its lines stating:

"Starting November 8 and running to December 3, we are cooperating with horticultural officials and authorities in this state, also with the U. S. D. A. in conducting an orchard clean-up campaign along our lines in Texas. . . . Our working force of practical scientific men will go into the field to prune, spray, dehorn and teach the care of orchards with all its relationship to the proper setting of fruit to all communities who desire this work."

Entomological Quarantine and Inspection

This problem is becoming increasingly prominent, and frequently arises to bother the railroad as well as the shipper. Most disagreements occur entirely as a result of lack of understanding of the true situation.

The railroad entomologist would have jurisdiction over inspection of cars for the gypsy and brown-tail moths, keeping cars used for ship-

ment of sugar cane free of scraps as a measure against the sugar cane moth borer, observance of pink bollworm precautions, interpretation and execution of entomological quarantine regulations generally, and the promulgation of such railroad regulations as will enable the road to properly observe the quarantine orders of the various states with least loss and friction.

The Entomologist a Builder of Good Will

Good will is recognized by business as a distinct and often a prime asset. It is a commodity that is capitalized, purchased, sold, leased. And here the entomologist can function as a most important factor. He can keep in touch with growers, individuals as well as organizations, and dealers to their ultimate benefit and protection. He can issue timely warnings of possible or threatened epidemics; he can assist growers to obtain proper material or outfits for their control work; he can warn against fraudulent materials or irresponsible concerns; he can press the passage of proper laws to protect the grower; he can urge enforcement of laws, otherwise permitted to lie dormant; he can function as coöperator with county agents, state and government officials; he can conduct demonstrations, schools and even correspondence courses; he can assist local health authorities along the line of elimination of flies, mosquitoes, etc., thereby being conducive to better living conditions, increased colonization, higher real estate values and greater prosperity and happiness generally.

President W. C. O'Kane: The paper is before you for discussion.

Mr. Leonard Haseman: I would like to know if any entomologist at present represents a railroad.

Mr. V. I. Safro: Before the war, I knew personally about eight or ten who devoted their entire time to such problems. There were in addition to these, two or three dozen who were primarily engaged in other work, but spent part of their time on entomological problems. The return of the railroads to their private owners will be an incentive to the railroad agriculturists to begin to organize their departments along solid definite lines.

Secretary A. F. Burgess: It seems to me that this paper is timely and has pointed out a field of activity that a good many of us have never considered. I can see where there might be some opportunities along this line that would be beneficial not only to the railroads and their shippers but to the entomologists as well.

Mr. C. L. Marlatt: One important point that the paper brought out which I want to emphasize with a word or two is the necessity for the inspection and clean-up of freight cars at the point of des-

tination. You recall, perhaps, the reports that have been published in our monthly Service and Regulatory Announcements of the findings in freight cars. You remember, perhaps, the items in relation to carriage of the potato beetle and also refuse Florida oranges and vegetables from Chicago to California. As a result of those findings, the Secretary of Agriculture addressed a letter to the railroad administration asking if measures could not be enforced to compel the cleaning of freight cars at the point of discharge of the contents, in order to prevent the carrying of pests. I think that is something that should be followed up.

PRESIDENT W. C. O'KANE: We will now listen to Mr. Pierce's paper on "Commercial and Professional Entomology—The Future of Our Profession."

COMMERCIAL AND PROFESSIONAL ENTOMOLOGY—THE FUTURE OF OUR PROFESSION

By W. DWIGHT PIERCE, *Consulting Entomologist, The Gage-Pierce Research Laboratories, Incorporated, Denver, Colo.*

We have for so many years looked upon entomology as either a pastime of men engaged in other occupations, or as a salaried federal, state or institutional profession, that we are apt to forget another very important branch of the science. In fact the rolls of our society have contained but few names of men who could not be classified under one of these heads. But this year it is different, and in coming years, the time is not far distant when the commercial and professional entomologists will outnumber their fellows.

For at least ten years there has been a strong undercurrent of discussion among the younger men in our science looking forward to the time when entomology would be unshackled and able to raise its head among the professional sciences. Many of us have realized the absolute impossibility of great progress in entomology until we could have at least as large a body of men unhampered by institutional or legislative restrictions, as there were under those conditions. We saw that when that happy day arrived the average pay in our profession would naturally be greater, because when a man has a chance to be a free agent he can bargain better for his salary. I recognize the fact that what I will say may open an entirely new line of thought to some of you and that some will not like to hear it. But I believe the majority will rejoice with me that the day is now at hand when entomology steps forth into new fields to make a new name for itself, as one of the great enconomic professions of the new world era.

I do not know positively how many men are already in the practical

field but when two of us stepped out of the harness on the same day with identical purposes there were many skeptics regarding the possibility of our making a living. They are probably still skeptical and to such as assume such an attitude there is no future outside of the subsidied ranks.

If in the beginning entomologists had started out as professional and consulting specialists, matters would have been quite different. It happened, however, that the public had first to receive a long course in instruction as to what we as a profession could accomplish. Governmental and state institutions were about the only means available for proving our worth. The world knows what we can do now. They are willing to pay us for our expert advice, provided, of course, we make a reputation for giving correct advice. As a matter of fact there are many people on this earth who would rather pay for advice than receive it free, and many would rather have some one do a technical piece of work for them for a higher price and feel that it was done right than do it themselves. That is the reason I say that the day is come when a well trained man can hang up his shingle as a consulting entomologist and make a successful business of it.

I would not advise a man to start out this way without a little capital, for no professional man gets into full swing in the first year of his practise. As a matter of fact some of us decided several years ago that it would be necessary to have two years living expenses laid up in reserve.

What better combination could we have for the man just starting out, than a little rented plot of ground with a truck garden on which he can experiment, and some hives of bees? His shingle hanging over the door, and a neat business card and letter head, with a simple announcement in the local papers would open the ball. He would build up as large a private library as he could from free publications and then buy more important volumes as he was able. He must be a good mixer and go out among the farmers and business men who may have need of him and show that he knows what he is talking about. He must have sufficient imagination to see new fields of effort and then try to get into them. He should endeavor to secure the agency of a good series of insecticides and machinery for applying them. It would pay him to give free demonstrations occasionally. He will soon have assistants on the job.

I have mentioned bee culture. I wonder how many of us realize what a paying business it is when properly conducted. There are great futures in honey production and you can easily get your start while holding on to the position you now occupy. If you let the apiary grow normally you will soon find you must part either with position

or with the bees. To be a producer in this world is a great thing. Think hard before you choose to stay with that salary.

The commercial field is linked absolutely with the professional. There will be some men who will elect only to do advisory work, and remain aloof from the practical application. There will be some who will undertake sanitary projects only, and some who will elect to go forth with spraying outfits or gas generators, but I believe that most of us will combine the consulting, the practical application, and the purely commercial.

What is the field of commercial entomology? It is the largest field for development in our science, although few have yet learned it. Modern business is being cast into new lines. Pick up any current magazine and glance at the advertisements of all industry and see how the emphasis is put upon scientific management, scientific processes, etc. Open your eyes to what is going on in the business world and you will see that the great manufacturers of America know that to survive in the new order of things they must have the best technical advice available in the world today. Do you know any place where your technical knowledge would benefit some great business? If you know and do not act it is because you are not alive to your own potentiality. Modern business will give you every opportunity to prove your ability and will pay you what you are worth. Furthermore the modern business man is alive to the value of having his men attend meetings and conventions; to well worded advertisements written by men who know what they are talking about; and to scientific publications from the pens of his employees. There is nothing admired more in business than brains, and foresight and initiative. If you can show a business man where you can make him money or save money for him you can name your price.

As a salaried technical man in the industries you are in reality an independent, because rival corporations are watching your results and will bid for you if they see you can better their business. Furthermore in the business world you rise or fall on your own merit and not because of secret machinations of officialdom. You may make enemies but business enmity is more open. You are constantly at the seat of commercial warfare and you know that you must give results. You will be free from the laissez-faire policy which has so retarded the progress of official entomology.

I will now speak of the field in which I am most interested. It is a combination of investigation, consultation, demonstration, practise and manufacture. Why should we not carry our work beyond the mere investigation and when we find a new insecticide, manufacture it, or arrange to have it manufactured? Hence the desirability of

uniting forces with men of other professions who can coöperate with us. Thus the metallurgist, chemist, entomologist, and agriculturist make a fine combination. One needs a particular insect controlled, another finds out how to control it, the third finds how to make the substance, and the fourth extracts it from the raw materials.

In the future we are going to have new series of insecticides. We are going to have insecticides which will conform more nearly to standards. We are going to find out more accurately how insecticides kill, because it will be our business to make the most efficient killing substances we can get. We will not put out substances that will kill the insect and also injure the plant or animal we want to protect, because we must continue to sell and the public will not buy unless we give results.

Are we not naturally going to get greater progress in insect control when entomologists are in the ring trying to learn the very basic principles of control so that they will have the best product on the market? Can you not see the great stimulation which modern business is giving to research? The commercial research man is given definite practical problems to solve. He knows that when he solves them, they will be put into practise and commuted into the coin of the realm. He also knows that there will be a suitable reward for his industry.

Men are going to be in demand. But they must be men who are wide awake to the field. They must be men who are thinking about these things and studying to equip themselves for this great field of future investigations. More men must be trained. And the training of entomologists for practical life is quite different from the training for pure science. Our professors must begin to think out new courses of training, with practise as the dominant note.

New insecticides acting along new principles will from time to time appear on the market and our colleagues in official positions will find they must give these fair tests. There must be open mindedness on both sides. We must have coöperation and fellowship in our science. If the official investigators need a particular substance put on the market in sufficient quantity and of proper quality at prices which will bring results, they will get results quickest through active coöperation with their professional brothers who are in a position to do this. The official worker has a problem to solve and wants to try many new substances but finds them difficult to obtain. If he calls in his professional colleague and asks his coöperation, between them they will get results.

We can not insist too often on the necessity of forever relegating to the past the days of the selfish investigator who tries to do all his work alone so that no one else can participate in the credit. We have ar-

rived at an age of coöperation in groups, so that we may progress faster in the solution of the great problems lying before us. Two or three or more men working together and frequently conferring on the progress of their work can do twice as much work as those same men working separately, each jealous of the other's progress.

During the past year quite a number of us have entered this new profession and in the future many more of you will follow suit. My next words are addressed to you future consulting entomologists. First of all we must be actively associated together so that we can pull for each other, and when calls for assistance come which would more normally be in another man's territory we can exchange services. By starting right we can be mutually helpful and build up a corps of experts in this country that the nation will respect. If we start wrong with the idea of grabbing every job for ourselves and letting our fellows starve; if we undercut the other fellow; cast slurs upon his reputation and in every way conceive enmity toward him because he is a rival specialist, we get nowhere. How closely we can associate ourselves depends upon our good will toward each other and the prospects before us. It may be merely to exchange views, it may be to exchange prospective clients, it may be to link ourselves into a closely knit financial coöperation.

Every man trained in entomology will not necessarily be a good man to enter this new field. He must be able to accommodate himself to his clients' way of thinking and find a way to help that will be understood. He must know how to advertise his brains and his wares convincingly, and must refrain from going over the heads of clients. But above all he must either know how to solve his problems or who can solve them for him.

In other words our professional man has to be an all round entomologist or have enough assistants or associates to cover the whole ground. If he does not know offhand the answer he must know how to get the answer.

This brings us back to the school training. You can not go into the commercial field and be in ignorance of ordinary business law. You must know how to give financial accounting to the government and to your associates. You must know how to figure costs and profits. Thus an orchard owner comes and asks you to bid on the spraying of his orchard. You look it over, and when you are through you must make him a bid which will correctly cover the costs of labor and supplies and yield you a modest fee. There will be competitors, so you must be able to get your supplies at the best figure and must do a job that will give satisfaction. In other words the future curriculum will embrace commercial arithmetic. I would advise a course in

mapping, charting, plotting, and interpretation of statistics and data, because very few people really grasp the meaning of a mass of figures. It is a subject worthy of intensive study. The proper presentation of your data is essential to the success of your work.

As to entomological training, unquestionably the pupil must be given the theories of insect behavior, classification, and control, but more important than that, he must be taught how to recognize the insects in the field, how to recognize their work. He must be an outdoor man with a keen eye, and should take copious notes. The man who can properly place insect damage and because of his knowledge of insect habits can immediately advise at least temporary expedients is worth more than the indoor theorist who can tell you what to do when he gets a proper determination. We are rapidly learning how to identify the insect from its immature stages. The teacher can not too strongly emphasize all that he can gather together on this subject. Of course the theory of control must be taught but I would combine it with actual experience with the apparatus in the field. Have the student actually undertake the control. He won't forget what he has done. He may easily forget what you tell him.

So let us all work together to build up the future of our science. We stand today at the threshhold of a new era. Will entomology knock at the door of opportunity and ask admittance to the council rooms of the elect or will we slink along and greedily take the crumbs that are condescendingly thrown our way? Too long has it been the custom in entomological circles to push aside ambitious programs for improvement and enlargement of our work with the remarks that such programs are not according to precedent, or that we would be turned down if we made such a proposal, and so opportunity after opportunity has died because of that obsessing fear that defeat would result.

Defeat will most assuredly come to him who makes a suggestion expecting at the time it would be turned down.

The war has caused the world and especially the American people to look quite differently at the problems which face us. We see now that things must be done on a far more comprehensive scheme, that community and state or national coöperative action is necessary to accomplish the tasks of the new era. We entomologists, trained in a school of conservatism, must adjust our viewpoint to the new situation.

Service is the standard by which all professions will be rated in the coming days. No longer may we sit with satisfaction at our desks and calmly study our insect problems with no care as to the general public. The nation is watching us. They know that we hold the keys to the problems of agricultural loss and the loss of health, or that we should hold them if we don't. Now the public wants service, and

service that can be recognized as such. Are we ready to give it? Are we willing to adjust our ways and manner of thought so that we can in the future give this service demanded of us?

PRESIDENT W. C. O'KANE: Is there any discussion on this paper? If not, we will go to the next paper, "Notes on Poisoning the Boll Weevil," by Wilmon Newell.

NOTES ON POISONING THE BOLL WEEVIL

RESULTS OF AN INVESTIGATION TO DETERMINE WHETHER THE PRESENCE OF DEW OR RAIN WATER ON COTTON PLANTS IS NECESSARY TO THE EFFECTIVE USE OF ARSENATES

By WILMON NEWELL and ELI K. BYNUM

While it is not our object in the present paper to review the history of the various attempts made to poison the boll weevil it is, nevertheless, pertinent to call attention to the fact that since the publication by the senior author and Mr. Geo. D. Smith, in 1909,[1] of experimental results which showed conclusively that the boll weevil could be profitably poisoned with powdered lead arsenate, close attention has been given this problem by the Bureau of Entomology. Since 1909 experiments with lead arsenate, and later with calcium arsenate, have been made at the Tallulah (Louisiana) laboratory of the Bureau, by Mr. Geo. D. Smith and subsequently by Mr. B. R. Coad, under the direction of Dr. W. D. Hunter.

After eight years of investigation the Bureau of Entomology, in July, 1918, finally committed itself to the proposition that the boll weevil can be poisoned with profit and has recently undertaken to promote the general use of arsenates, particularly calcium arsenate, for practical control of the boll weevil by cotton planters.

According to Bulletin No. 731, United States Department of Agriculture, by Mr. Coad, issued July 19, 1918, successful poisoning of the boll weevil is based upon the supposed habit of the boll weevil in drinking dew or rain water which collects on the cotton plants, this water presumably becoming poisoned by the application of calcium arsenate in the form of a dust or cloud.

Experiments made by Mr. T. C. Barber and the senior author of the present paper, in 1906, 1907, and 1908, seemed to show quite conclusively that mortality among the weevils, following application of an arsenical poison, was due to ingestion of the poison with their food, particularly when the poison was applied in such a way as to penetrate between the tender leaves in the terminal buds of the cotton plant or

[1] Circ. 33, Louisiana Crop Pest Commission, Dec. 1, 1909.

to cover the cotton square (bud) itself.[1] It was upon these results that the field work of 1909, by Mr. Geo. D. Smith and the senior author, was based and which showed an increased yield of cotton averaging 71 per cent in the poisoned plats of thirteen field experiments.

The question of whether the boll weevil is killed through ingestion of poison with its food or through drinking dew or rain water containing the poison is an important one, as bearing upon practical work in controlling the insect. If mortality is due to ingestion of the poison while the weevil is feeding manifestly that method of application will be most successful which places the poison directly upon those portions of the plant where the weevil is most likely to feed. On the other hand, if mortality is due to the weevil being poisoned by imbibing dew or rain water on the treated plants, any method of wholesale distribution of the poison throughout the cotton field will accomplish the desired purpose. The machinery used in these two methods of application will vary greatly and a correct understanding of the manner in which the weevil is poisoned by the use of lead or calcium arsenate will, therefore, prevent needless expenditure by the cotton planter in machinery which is not adapted to the purpose and also tend to increase the efficiency of the poisoning operations.

For the purpose of determining the point mentioned very careful experiments were conducted at Madison, Fla., during the summer of 1919, the work being immediately in charge of the junior author, assisted by Messrs. A. C. Brown, K. E. Bragdon, J. C. Goodwin and Walter F. Eberhardt, of the Florida State Plant Board. The work was inspected at frequent intervals by the senior author. Office and laboratory facilities at Madison were generously made available for us by Dr. W. D. Hunter of the Bureau of Entomology.

The powdered arsenate of lead used in these experiments was represented by the manufacturer to contain "not less than 30 per cent" of arsenic oxide and "less than 1 per cent" of water soluble arsenic.

The powdered calcium arsenate used was represented to contain "total arsenic oxide 40 per cent" and water soluble arsenic "$\frac{3}{4}$ per cent" and met the specifications laid down by Mr. B. R. Coad for calcium arsenate suitable for boll weevil poisoning.

Experiments were made under field conditions and also in the laboratory. The former will be first discussed.

Field Cage Experiments

The field experiments were conducted in cages 3 x 3 feet, $4\frac{1}{2}$ feet in height, of 16-mesh galvanized wire-cloth, made as nearly insect-tight as possible. Cotton plants in the field were treated with calcium

[1] Circ. No. 23, Louisiana Crop Pest Commission, July, 1908.

arsenate and others with lead arsenate, using approximately ten pounds of the poison per acre. Cages were then placed over individual treated plants (see fig. 1), each cage floored with paper as tightly as possible and fly paper placed around the outside lower edges of the cage to exclude ants and a counted number of field-collected boll weevils introduced into each cage. Certain cages were covered at night and during showers with a heavy oilcloth cover, extending to within 12 inches of the ground (see fig. 2) so that the plants were protected against all deposition of visible moisture. Other cages, paired with these in the experiments, were not supplied with covers and the plants in them received the same precipitation of dew and rain as plants under normal field conditions, except that covers were placed on them when severe storms occurred in order to prevent excessive washing off of the poison or possible drowning of the weevils.

Corresponding cages, both "covered" and "uncovered," were placed over non-poisoned plants to serve as checks. Observations were made twice daily in all cages to determine the mortality among the weevils. The following table, showing the results obtained in two series of experiments, using lead arsenate and calcium arsenate on both covered and uncovered plants, is typical of the observations made on the total of 2,250 weevils used in the field experiments.

TABLE I. MORTALITY AMONG BOLL WEEVILS ON PLANTS PROTECTED FROM DEW AND RAIN ("COVERED") AND ON PLANTS EXPOSED TO DEW AND RAIN ("EXPOSED") FIFTY WEEVILS PER PLANT, ONE PLANT PER CAGE SIX CAGES POISON APPLIED 7 P M, SEPTEMBER 16, BY DIRECT APPLICATION WITH DUST SPRAYER ("BLAST METHOD") AT ABOUT 10 POUNDS PER ACRE.

Date	Number weevils dead each day				Check ("natural mortality")	
	Treated with lead arsenate		Treated with calcium arsenate			
Sept	Covered* (Ser I) (50 weevils)	Exposed† (Ser II) (50 weevils)	Covered* (Ser I) (50 weevils)	Exposed† (Ser II) (50 weevils)	Covered* (Ser I) (50 weevils)	Exposed† (Ser II) (50 weevils)
17	3	2	3	0	0	0
18	4	5	4	6	0	0
19	13	11	17	9	1	0
20	11	11	8	6	0	0
21	4	3	2	2	0	0
22	6	3	4	3	0	0
23	4	4	4	3	1	0
24	2	2	0	3	0	0
25	1	2	2	0	1	4
Totals	48	43	44	32	3	4
Weevils alive at end of exp.	2	2	1	4	28	38
Missing	0	5	5	14	19	8

* No visible moisture on plants at any time during experiment

† Heavy dew on plants on Sept. 17, 24 and 25; medium dew on 19th, 20th, 21st, 22nd and 23rd and light dew on 18th

In all, nine series of experiments, such as described above, were made. Each "series" consisted of one cage-covered cotton plant treated with lead arsenate, one with calcium arsenate and one check cage, the latter containing the same number of weevils used in each of the other cages, in order to determine the "natural" mortality.

Observations were made twice daily on 750 weevils confined on plants treated with lead arsenate, 750 on plants treated with calcium arsenate and 750 confined on non-treated cotton plants but which were otherwise under the same conditions as those on the treated plants.

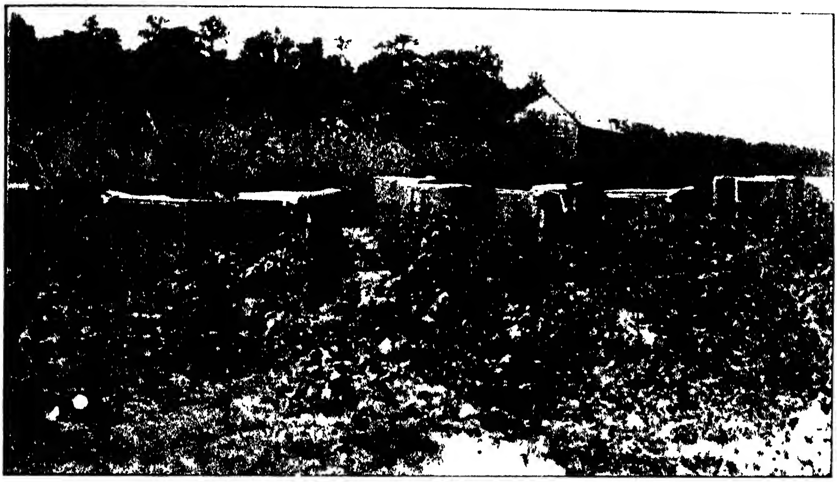
The following table shows the daily mortality, in percentages, among the weevils on plants treated with lead arsenate when protected from dew and rain, namely, kept entirely dry during the course of the experiments, and on plants similarly treated which were exposed to normal deposition of dew and light rains, being protected only from severe storms.

The deposition of dew on the exposed plants was of almost daily occurrence, heavy dew occurring on 20 mornings, medium dew on 17 mornings, light dew on 9 mornings and no dew on 10 mornings during the 60 "experiment-days" that these investigations were under way. Light rain fell on one morning. During the course of the experiments only one storm occurred which required the covering of the cages which were under "normal" conditions as to precipitation of dew and rain.

Of the nine plants treated with lead arsenate, three received the poison by the direct application or "blast" method and six by the "cloud" method as advocated by Coad. Of the three receiving treatment by the former method one was protected from all dew and rain and two were exposed to normal precipitation. Of the six treated by the cloud method two were protected from dew and rain and four exposed to normal precipitation.[1]

Poison used	Method of application	Number of weevils	Mortality during 10 days, per cent
Lead arsenate....................	Blast	150	88.6
Lead arsenate	Cloud	600	74.7
Calcium arsenate.................	Blast	150	79.3
Calcium arsenate	Cloud	600	74.2
Check...........................	None	750	16.1

[1] Although the primary object of these investigations was to determine *how* the weevil obtains sufficient poison to produce death, the experiments were, nevertheless, so arranged as to give data on other questions. The data have been tabulated, for example, to show the mortality resulting from application of lead arsenate by the blast or direct method and by the cloud or settling method; also to show the comparative mortality when calcium arsenate was applied by both these methods. This information is summarized in the following table which shows the mortality among the boll weevils during the first 10 days following the applications:



Type of cages used over treated cotton plants in the field to determine mortality among boll weevils under varying conditions (Original.)

Type of oilcloth covers used to prevent deposition of dew on certain of the treated plants.

TABLE II. PER CENT MORTALITY AMONG BOLL WEEVILS ON LEAD-ARSENATE TREATED PLANTS: (A) PROTECTED FROM DEW AND RAIN, AND (B) EXPOSED TO DEW AND LIGHT RAINS, DURING FIRST 10 DAYS AFTER TREATMENT

24-hour period after application	A		B	
	Protected from dew and rain		Exposed to dew and light rains	
	Treated (250 weevils in 3 cages) per cent	Check (250 weevils in 3 cages) per cent	Treated (500 weevils in 6 cages) per cent	Check (500 weevils in 6 cages) per cent
1st	7 2	0	9 0	1.4
2nd	8 8	0	11 4	1 4
3rd	18 4	2 8	12	1.2
4th	15 2	0	10	1.4
5th	9 6	0 4	7	1.4
6th	9 2	2 4	6 8	2.0
7th	7 6	4	5	0 4
8th	3 6	2 8	5.6	1.8
9th	2 4	2 4	3.2	3.2
10th	3 6	2 8	3.8	3 0
Total mortality	85 6	14 0	73 8	17.2

Comparison of the data in the above table is easily made by means of the following chart, in which the daily percentage of mortality is shown in the case of both the covered plants and those exposed to normal deposition of dew and rain.

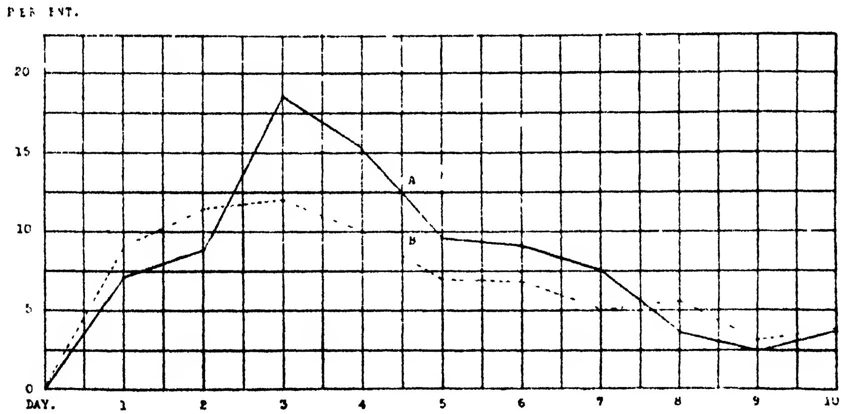


Chart 1.—Daily mortality, in percentages, among weevils on cotton plants treated with lead arsenate: heavy line (A), among 250 weevils on plants protected from all dew and rain; broken line (B), among 500 weevils on plants exposed to normal deposition of dew and rain.

The same information is also contained in the following chart, in which "A" shows the total mortality, during the first ten days after

application, on plants entirely protected from dew and rain and "B" the total mortality on plants exposed to light rains and normal deposition of dew. A_1 and B_1 show, respectively, the total natural mortality among weevils confined under identical conditions but on non-treated plants.

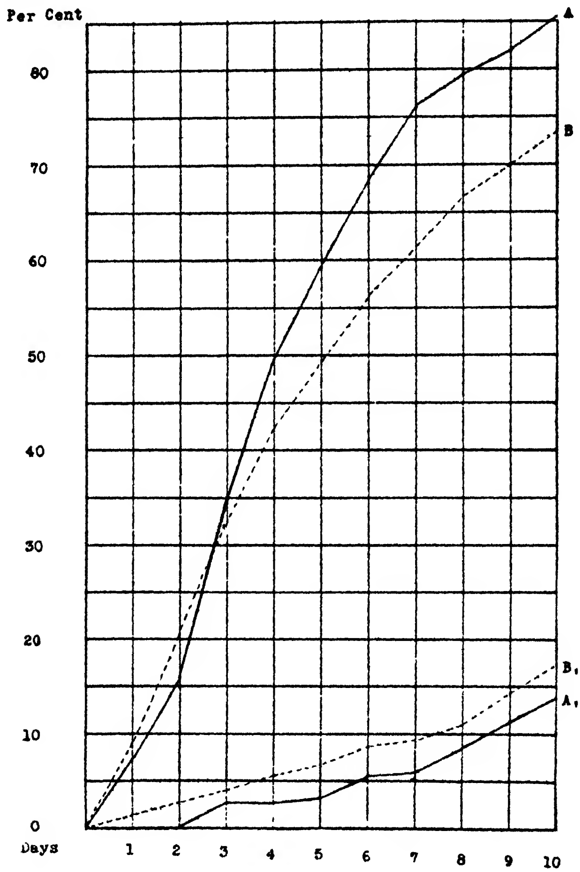


Chart 2.—Diagram showing total percentage of mortality among boll weevils on cotton plants treated with lead arsenate: A, on plants protected from all dew and rain; B, on plants exposed to normal precipitation. Also natural mortality among weevils on non-treated plants: A_1, on plants protected from all dew and rain; B_1, on plants exposed to normal precipitation.

Identical experiments were made using calcium arsenate, instead of lead arsenate, as the poison and using the same check cages. The following table shows the results obtained when using calcium arsenate, instead of lead arsenate, the arrangement of cages, method of applications, etc., being the same.

TABLE III. PER CENT MORTALITY AMONG BOLL WEEVILS ON CALCIUM-ARSENATE TREATED PLANTS: (A) PROTECTED FROM DEW AND RAIN, AND (B) EXPOSED TO DEW AND LIGHT RAINS, DURING FIRST 10 DAYS AFTER TREATMENT

24-hour period after application	A		B	
	Protected from dew and rain		Exposed to dew and light rains	
	Treated (250 weevils in 3 cages) per cent	Check (250 weevils in 3 cages) per cent	Treated (500 weevils in 6 cages) per cent	Check (500 weevils in 6 cages) per cent
1st	8.8	0	13.6	1.4
2nd	14.0	0	15.4	1.4
3rd	19.2	2.8	11.6	1.2
4th	10.8	0	8.6	1.4
5th	4.8	0.4	5.8	1.4
6th	6.0	2.4	4.0	2.0
7th	6.4	0.4	4.6	.4
8th	3.2	2.8	4.8	1.8
9th	3.2	2.4	3.0	3.2
10th	2.4	2.8	2.4	3.0
Totals	78.8	14.0	73.8	17.2

The following chart shows the above information in graphic form, *i. e.*, the daily mortality on treated plants protected from dew and rain and on treated plants exposed to normal precipitation.

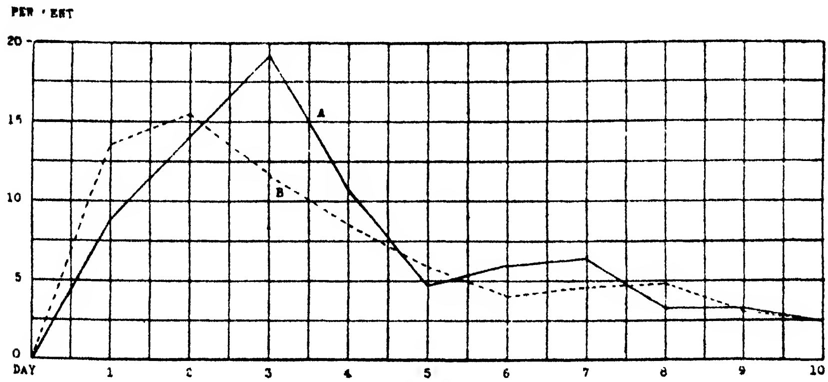


Chart 3.—Daily mortality, in percentages, among weevils on cotton plants treated with calcium arsenate: heavy line (A), among 250 weevils on plants protected from dew and rain; broken line (B), among 500 weevils on plants exposed to normal deposition of dew and rain.

Chart 4 shows in graphic form the total percentage of mortality as given in Table III and Chart 3.

The increased mortality among the weevils on treated plants protected from dew and rain, as compared to the mortality on treated plants exposed to deposition of dew and rain is very marked.

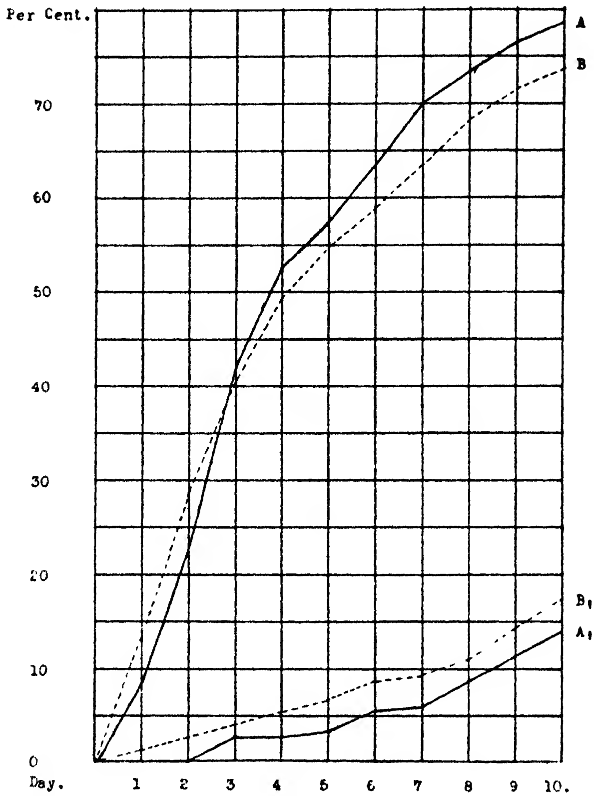


Chart 4.—Diagram showing total percentage of mortality among boll weevils on cotton plants treated with calcium arsenate: A, on plants protected from all dew and rain; B, on plants exposed to normal precipitation. Also natural mortality among weevils on non-treated plants: A_1, on plants protected from all dew and rain; B_1, on plants exposed to normal precipitation.

Reference to Table II shows that, using lead arsenate, the mortality on protected plants was 85.6 per cent during 10 days and on exposed plants was 73.8 per cent. During the same period the natural mortality, as shown by the weevils on non-treated plants, was 14 per cent on plants protected from dew and 17.2 per cent on plants exposed to dew. The mortality creditable to the lead arsenate was therefore 71.6 per cent in the case of the weevils on plants kept dry and 56.6 per cent on plants exposed to dew, or a mortality greater by 15 per cent on plants kept dry than that on plants receiving dew.

When calcium arsenate was used (Table III) the mortality on protected plants was 78.8 per cent and on "exposed" plants 73.8 per cent, the checks being as given above, giving a mortality, due to the poison of 64.8 per cent on dry plants and 56.6 per cent on plants exposed to dew, a gain of 8.2 per cent when the plants remained dry.[1]

The foregoing results seem to show conclusively that, as the mortality on dry plants was perceptibly higher than on those exposed to the deposition of rain and dew, the presence of visible moisture is in no way necessary to the effectiveness of either lead or calcium arsenate. This forces us to the conclusion that the weevil is killed by ingestion of the poison in feeding and not when drinking dew or rain water as claimed by Mr. Coad.

The investigation was, however, pursued along other lines, largely under laboratory conditions.

The Toxicity of Dew from Poisoned Plants

Investigations were also made to determine the amount of arsenic contained in dew which was deposited on cotton plants which had been treated with both lead arsenate and calcium arsenate. Upland cotton plants in the field were treated by dusting them with lead arsenate in the usual manner, at the rate of about 8 pounds per acre. Other plats were treated in like manner with calcium arsenate. The dew was collected from these plants, early in the morning, by the use of shell or specimen vials. It was found that by carefully touching the lip of the vial to the dew drops suspended from the edges and tips of leaves that the dew could be, though rather tediously, drawn off into the vial and a sufficient quantity thus accumulated for laboratory experiments. Dew was collected only from leaves well covered with poison.

Dew collected in this manner was submitted to Mr. S. E. Collison, chemist of the University of Florida Experiment Station, for quantita-

[1] The data secured in these experiments affords an interesting comparison between the effectiveness of lead arsenate and of calcium arsenate.

On plants protected from moisture the mortality ascribable to lead arsenate (Table II) was 71.6 per cent and to calcium arsenate (Table III) 64.8 per cent, a difference in favor of the lead arsenate of 6.8 per cent, but the mortality ascribable to lead arsenate on "exposed" plants (Table II) was 56.6 per cent and to calcium arsenate (Table III) also 56.6 per cent.

In the case of application by the blast method, all experiments, lead arsenate gave a mortality of 88.6 per cent during ten days and calcium arsenate a mortality of 79.3 per cent, a margin of 9.3 per cent in favor of lead arsenate. Applications by the cloud method, all experiments, gave a mortality with lead arsenate of 74.7 per cent and with calcium arsenate a mortality of 74.2 per cent. The mortality in the check was 16.1 per cent (see footnote, p. 9).

tive analysis. The following table shows the number of parts of arsenic per million in the dew as determined by Mr. Collison. Each sample of dew analyzed was collected from leaves well covered with poison from several dozen plants in different parts of the treated plat and the arsenic content may, therefore, be considered as decidedly above the average arsenic content of dew on treated plants.

From plants treated with	Dew collected	Parts arsenic per million
Lead arsenate	First morning after application	6 7
Lead arsenate	Second morning after application	6 7
Calcium arsenate	First morning after application	43 5
Calcium arsenate	Second morning after application	10 00

From the foregoing it is seen that the actual amount of arsenic in the dew from treated plants is remarkably small, even when collected from leaves heavily coated with the arsenate, and presumably a weevil would have to consume very considerable amounts of it in order for it to prove fatal. Experiments were accordingly made to determine whether such dew would prove fatal to boll weevils when all other sources of moisture were eliminated.

Large battery jars were prepared, each jar having a layer of dry sand in the bottom and the top covered with cheesecloth to permit circulation of air. A counted number of field-collected weevils was introduced into each jar and thereafter supplied with dew, collected from the treated plants the morning following the application of poison, by placing the dew in shallow tin trays. No other water was supplied and the weevils had no food. Corresponding lots of field-collected weevils were kept in similar jars, but supplied with clear water instead of dew and the daily mortality noted. Under these conditions the weevils went rather frequently to the dew in the trays and remained with their beaks inserted in the dew for periods varying from 1½ to 5 minutes, 2¼ minutes being about the average. It is assumed that they were drinking during these periods.

The mortality, during 10 days, among 80 weevils supplied only with dew from lead-arsenate treated plants was 80 per cent, among 80 with dew from calcium-arsenate treated plants was 68.7 per cent and among 80 with clear water was 43.7 per cent; all of which is shown in the following chart:

In the course of these experiments one weevil lived for 12 days on an exclusive diet of dew from calcium-arsenate treated plants and

two lived for 13 days and one for 19 days on dew from lead-arsenate treated plants.

From the foregoing chart it is seen that the mortality was not appreciable until the weevils had been drinking the poisoned dew for more

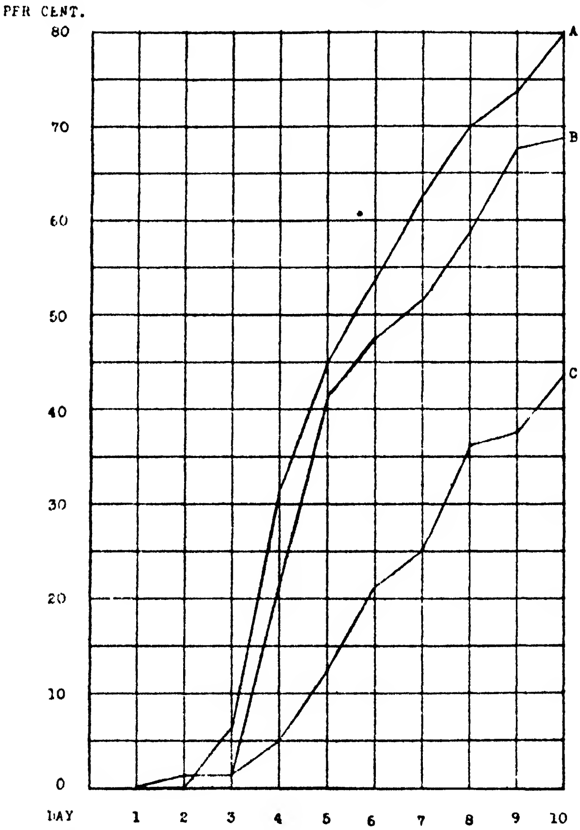


Chart 5.—Total percentage of mortality among weevils deprived of all food and furnished only with: A, dew from plants treated with lead arsenate; B, dew from plants treated with calcium arsenate; C, clear water.

than three days. Therefore, under normal field conditions the mortality caused by drinking dew containing poison is so small that no practical degree of control through this cause can be expected. Besides, a careful study of the weevil's habits indicates no tendency to drink dew in such quantities as would be necessary for successful poisoning if the weevil secures the poison mainly or entirely in this way.

The following experiments approximated field conditions in that weevils were furnished with both dew from treated plants and with fresh cotton squares as food.

Mortality Among Weevils Supplied with Food and with Dew from Treated Plants

Field-collected weevils were confined in battery jars as described in the preceding experiments, furnished with dew from treated plants in the same manner and in addition given fresh cotton squares each morning. They, therefore, had cotton squares as a source of both food and moisture, as is the case in the field, and in addition had dew constantly available for drinking purposes. The mortality, during 10 days, among 80 weevils confined with dew from lead-arsenate treated plants, 80 confined with dew from calcium-arsenate treated plants and 80 confined with clear water is shown in the following table.

Table IV. Daily Mortality Among Boll Weevils Supplied with Food and with Dew from Poisoned Cotton Plants

Liquid	Number weevils confined	Daily mortality										Total dead during 10 days	Per cent mortality during 10 days
		1	2	3	4	5	6	7	8	9	10		
Dew from lead-arsenate treated plants....	80	0	0	0	0	0	1	2	0	2	1	6	7.5
Dew from calcium-arsenate treated plants.... .. .	80	1	0	0	0	0	1	0	1	1	1	5	6.2
Water ("check").......... ..	80	0	0	0	0	1	0	1	1	5	0	8	10.0

As the mortality among the weevils having access to water was fully as great as that among those having access to the poisoned dew it is at once evident that either the weevils did not partake of the dew or they did not drink enough of it to cause any mortality. It is to be remembered, in this connection, that the dew to which these weevils had access was collected the first morning following the application of arsenates and only from leaves which showed a relatively heavy coating of the poison.

Summary

1. The mortality among boll weevils on cotton plants treated with lead and calcium arsenates and kept protected from all rain and dew was appreciably higher than the mortality on plants similarly treated but exposed to dew and normal precipitation. As the presence of dew or rain water on the cotton plants does not increase the effectiveness of either lead or calcium arsenate as a boll weevil poison it is evident that mortality from the use of either of these poisons is brought about by ingestion of the poison with the weevil's food and not by drinking the so-called "poisoned dew."

2. Dew collected from cotton plants treated with lead arsenate at the rate of approximately 8 pounds per acre was found, upon analysis, to contain 6.7 parts of arsenic per million. Dew from plants treated

with calcium arsenate at the same rate was found to contain from 10 to 43.5 parts of arsenic per million. The dew was collected only from cotton leaves that showed a distinct, thorough white coating of the arsenates.

3. Boll weevils deprived of all food and having dew from treated plants as the only source of moisture suffered a greater mortality than boll weevils confined on clear water, showing that the dew contained sufficient arsenic to produce death when the weevils were *compelled* to take the dew and no other food or water over a period of several days. However, such a condition does not occur in cotton fields.

4. When boll weevils had access to food in the form of non-poisoned cotton squares and, at the same time, to dew from treated plants, no mortality resulted, showing that the weevil can be poisoned under normal conditions only by poisoning its food.

Conclusions

1. As the boll weevil is poisoned largely or entirely through taking poison with its food, machinery for applying poison to the cotton plants should be so designed as to apply the poison primarily to the squares, bolls and terminal buds, rather than to the foliage.

2. The greatest mortality among the boll weevils occurred on the third day following application of the arsenates and fell off rapidly after the seventh day indicating that, other things being equal, applications should be at intervals of a week, or less, apart.

President W. C. O'Kane: Do you wish to discuss this paper?

Mr. E. G. Kelly: Did calcium arsenate burn the tender foliage?

Mr. Wilmon Newell: I am not able to answer this question positively. In our experiments, it did not.

Mr. W. D. Pierce: I would call attention to the fact that in all of Mr. Newell's experiments, lead arsenate proved more effective than calcium arsenate. I would like to ask him as to the method of application that he found the most successful.

Mr. Wilmon Newell: In the case of both lead and calcium the highest efficiency was the method of application that forced the poison directly on the plants, as compared with distributing it in the form of dust clouds and allowing them to settle.

Mr. R. N. Chapman: I would like to ask how large numbers those percentages of mortality are based on.

Mr. Wilmon Newell: In the first table, in the protected cages, there were 250 weevils, and in the cages exposed to the rain and dew, there were 500 weevils.

Mr. R. N. Chapman: Do you think there would be any advan-

tage in applying the poison in a blast or cloud and putting it on the plants when they are wet?

MR. WILMON NEWELL: We have also tabulated the data so as to get information on that point. The mortality when the poison is applied to the wet plants is a little higher during the first 48 hours than when applied to plants that are dry. During the first four days, the mortality was practically the same in both cases.

MR. F. L. THOMAS: I am glad to hear this paper, as it shed new light to those who are carrying on similar experiments. In Alabama, in 1918, we carried out one test, the details of which I cannot recall, but in the cages that were treated, the one that was not exposed to dew had a greater mortality than the one that was.

PRESIDENT W. C. O'KANE: The next paper is entitled "Miscellaneous Soil Insecticide Tests," by J. J. Davis.

MISCELLANEOUS SOIL INSECTICIDE TESTS

By JOHN J. DAVIS, *Riverton, N. J.*

(Summary; Complete Paper to be Published Elsewhere)

Of the several materials tested against soil-infesting grubs, only emulsifiable creosote compounds, kerosene emulsion and sodium cyanide have given appreciable results.

Emulsifiable creosote compounds diluted 1 to 125 ("Carco" and "Barrett's Disinfectant" were used) and 10 per cent kerosene emulsion gave about 80 per cent kill for grubs of *Cotinis nitida* and 30 to 70 per cent kill for *Popillia* and other grubs which do not have a definite open burrow. Sodium cyanide, however, gave the best kill and when applied at 110 to 165 pounds per 12,000 gallons of water per acre a 90 to 100 per cent kill was obtained under favorable conditions. It is cheaper than either of the other two materials and is easier to prepare than the emulsion. Sodium cyanide was tested against the grubs of *Popillia japonica*, *Cyclocephala immaculata*, *Macrodactylus subspinosus* and *Lachnosterna* spp., the first mentioned species apparently being more resistant to the action of the insecticide than the others.

MR. Z. P. METCALF: I would like to ask Mr. Davis to give us some idea as to how deep the insecticide penetrated the soil.

MR. J. J. DAVIS: We had a very good kill—from 80 to 95 per cent killed—when the grubs were not deeper than two inches. When they were below that we got a very unsatisfactory kill. This was with an application of 165 pounds of granular sodium cyanide, dissolved in 12,000 gallons of water to the acre.

MR. GLENN W. HERRICK: I would like to ask Mr. Davis what effect that material had upon sod land, and upon the future crops?

MR. J. J. DAVIS: At 165 pounds to the acre it sometimes burned the grass slightly, but it did not destroy it outright, excepting where there were holes and where the solution stood for a length of time. There is no effect on any future crop; the cyanide disappearing within ten days to two weeks. We cannot apply it where there are growing, cultivated crops, like corn, without injury.

PRESIDENT W. C. O'KANE: The next paper is "Outline of Project Work in Extension Entomology," by E. G. Kelly.

OUTLINE OF PROJECT WORK IN EXTENSION ENTOMOLOGY

By E. G. KELLY, *Extension Entomologist of the Kansas State Agricultural College*[1]

Extension work in entomology means the carrying to the farmer, the ranchman, the gardener and the fruitgrower information as to the how, when and where of the methods of controlling his insects pests. In order to do this a definite plan must be made by the leader Furthermore, to put over a plan or project of so much importance as the one herewith presented it is necessary to have an effective organization. In Kansas we have such an organization in our Extension Service, namely the County Farm Bureau. Each County Farm Bureau has a county agent who is a member of the Extension Division. The extension entomologist, who is the leader of this project, is also a member. The county agent is the medium through which the entomologist reaches the farmers.

You will please note that the project deals first, with the combative period— meaning the time control measures may be effected—and second, with the educational period. The combative time may be during the active period of the insect or may be during the dormant period; the educational time should be any time convenient for a gathering of farmers.

Where there are a large number of county agents in a state, the time the entomologist can devote to each agent must be necessarily limited. In Kansas we have 60 county agents with the state divided into convenient conference districts. Definite dates are set on which to hold a conference each month; a special conference may be called any time in case of an emergency. The entomologist attends these conferences whenever it is desired and gives the county agents definite instruction as to handling the insect problem at hand. These conferences are held in the office of the Farm Bureau near the district center. The

[1] Contribution No. 53, from the Entomological Laboratory, Kansas State Agricultural College.

agent of this Farm Bureau furnishes fields, orchards or other necessary material for the demonstration to be given by the entomologist. Following the conference, the county agent then gives the necessary time to the project to cover his county. In cases of unusual activity of an insect the entomologist devotes 2 or 3 days to assisting the county agent in holding campaign meetings in his county, thus more definitely and thoroughly instructing the agent, and incidentally a few selected farmers, in the measures of control to be used.

The conferences throughout the state are held within as short a period as practicable. The time for the agents to begin work on the project is definitely determined and set so that all the agents in the several districts will be ready on or about the same date. Every county agent beginning the campaign at the same time, the publicity department of the college can send out news items to all big newspapers, the local newspapers and to the farm papers. In a very short time every farmer is talking, thinking and working on the project.

The conference plan of seeing the county agents, means that the entomologist will see 50 to 60 agents in 6 days or less; each agent will see his insect committee consisting of 20 to 25 farmers in his county during the next 3 to 4 days. Thus in this manner 1,000 farmers who are leaders of the insect projects in the state are fully informed within 6 to 10 days.

The educational part of the project is divided into four parts: first, the follow-up; second, the county fairs; third, the farmers' institutes; and fourth, the extension schools. The follow-up program is that part of the work done by another department of the Extension Division, known as the home study department. The entomologist writes one or more short lessons on the subject which he is demonstrating to the county agent and farmers. The home study department then sends a mimeographed copy of these lessons to every farmer in the county immediately after the agent and entomologist complete the two or three day campaign.

The county fairs afford opportunity to show results of insect control, especially on fruit and garden truck and for meeting many farm men and women not otherwise available. The farmers' institute permits the meeting of many people. Here the extension school is advertised and what can be done at such school indicated. The extension school in Kansas is of from 3 to 6 days duration and is for farm men and women. A few pertinent lessons are given on timely subjects, allowing the entomologist to instruct a few men and women on definite problems. It has often been observed by extension workers that 25 men in a community taught a lesson is the means of the dissemination of that lesson to 150 to 200 men in a very short time.

PROJECT—ENTOMOLOGY

Combative month	Name of insect	Time allotted to project		Educational		Month
		Days for entomologist	Days for county agent	Follow-up subject matter lesson sheets	Ext schools, farmers' insts county fairs	
June July Aug Sept.	Hessian fly	County agent conferences 6 days, with each county agent 1 to 3 days for meetings if pest unusually bad	14 to 20 days organizing and instructing farmers on methods of control	1 Life history and habits 2 Seasonal history 3 Control measures 4 Plants attacked 5 Bulletins		Oct Nov Dec Jan Feb.
Nov Dec June July	Chinch bug	County agent conferences 6 days, with each county agent 1 to 2 days for meetings when pest is unusually bad	14 to 20 days in fall 14 to 20 days, in spring organizing and instructing farmers on methods of control	1 Life history and habits 2 Seasonal history 3 Control measures (a) Fall burning (b) Barriers 4 Plants attacked 5 Bulletins		Oct Nov Dec Jan Feb.
March April May	Green bugs	County agent conferences 6 days continuously in infested fields during outbreak	14 to 20 days continuously during outbreak	1 Life history and habits 2 Seasonal history 3 Methods of control 4 Plants attacked 5 Bulletins		Nov Dec Jan Feb.
March April May June July Aug Sept	White grub	With each agent in infested district 1 to 3 days for meetings	As many days as needed to cover infested district	1 Life history and habits 2 Seasonal history 3 Crops attacked 4 Methods of control 5 Bulletins		Nov Dec Jan Feb
March April May June	Cutworms	County agent conferences 6 days, with each agent in infested district 1 to 2 days for meetings	14 to 20 days organizing and instructing farmers on methods of control	1 Life history and habits 2 Seasonal history 3 Crops attacked 4 Methods of control 5 Bulletins		Nov Dec
April May June July Nov Dec	Grasshoppers	County agent conferences 2 days, with each agent in infested district 2 to 3 days for meetings	10 to 20 days organizing and instructing farmers on methods of control	1 Life history and habits 2 Seasonal history 3 Crops attacked 4 Methods of control 5 Species involved 6 Bulletins		Oct Nov Dec Jan Feb
June July Aug Sept	False wire-worms	County agent conferences 2 days	5 days organizing and instructing farmers on pest	1 Life history and habits 2 Seasonal history 3 Crops attacked 4 Methods of control 5 Species involved		Oct Nov Dec Jan Feb
May June July Aug	European corn borer	All of time in all situations	Continuously on guard	1 Life history and habits 2 Special instructions to county agents and farmers as to possibility and method of its being introduced into Kansas 3 Plants attacked 4 Bulletins		Nov Dec Jan Feb March
April May June July Dec. Jan Feb March	Fruit insects Codling-moth San José scale Canker Worm Curculio Apple Aphis Apple leaf skeletonizer Apple leaf hopper Apple-tree borer Peach-tree borer	With each agent in April 4 days, in May 4 days, in June 2 days; in September and October roundup; judging results in orchards and exhibits at county fairs 2 to 3 days; orchard tours 6 to 8 days	8 to 10 days organizing orchard clubs, etc, for pruning and spraying demonstrations	1 Life history and habits 2 Spraying schedules 3. Insecticides and fungicides 4 Orchard management 5 Bulletins		Sept. Oct Nov. Dec. Jan Feb

PROJECT—ENTOMOLOGY—*Concluded*

Combative month	Name of insect	Time allowed to project: Days for entomologist	Time allowed to project: Days for county agent	Educational: Follow-up subject matter lesson sheets	Educational: Ext. schools, farmers' insts. county fairs	Month
March April May June July	Garden insects: Potato beetle Blister beetle Stalk borer Cabbage worm Cutworm Aphis Striped cucumber beetle		5 or 6 days	1 Life history and habits 2. Spraying and dusting 3 Management 4 Bulletins		Nov Dec Jan Feb
June July Aug. Sept	Insects affecting stored products: Weevil Angumois grain moth	With each agent in territory affected 1 day	6 days	1 Life history and habits 2 Methods of control 3 Bulletins		Nov. Dec Jan. Feb
May June July Aug Sept.	Insects affecting livestock. Stable fly Bot fly Horn fly Lice Screw worms Ticks Scab mite	County agent conferences 8 days; in county where affected seriously 1 or 2 days	County agent 10 days	1 Life history and habits 2 Animals attacked 3 Methods of control 4 Bulletins		Nov Dec. Jan Feb
April May June July Aug. Sept.	Insects affecting the health of man	Entomologist in cooperation with home demonstration agent; in each county 2 to 3 days	20 days	1 Life history and habits 2 Control measures 3. Methods transmitting disease 4 Bulletins 5 Lectures		March April May June July Aug.

PRESIDENT W. C. O'KANE: The next paper is "Two 'Spray Your Orchard Week' Campaigns in Mississippi," by R. W. Harned and O. I. Snapp.

TWO "SPRAY YOUR ORCHARD WEEK" CAMPAIGNS IN MISSISSIPPI

By R. W. HARNED and OLIVER I. SNAPP

The San José scale was first introduced into Mississippi and other southern states in 1891, and since has been allowed to spread and increase without any attempt on the part of deciduous fruit growers in this region to check its progress, until 1917, when it was safe to say that from 85 to 90 per cent of all deciduous fruit trees in the state of Mississippi were more or less infested with the pest.

The terrible devastation of Mississippi orchards by this pest, and the decided lack of a general knowledge of spraying throughout the entire state led us to take some vigorous step to correct these conditions. A "Spray Your Orchard Week" campaign was, therefore, organized during the summer of 1917, and December 9–15 designated as the special spray week. This was a part of the program for stimu-

lating food production during the emergency. The aim of the campaign was to influence every farmer in Mississippi who had an orchard to spray it for San José scale.

A meeting of representatives of the various spray machinery and spray chemical manufacturers with the horticulture, entomology and other coöperating departments of the Mississippi A. and M. College was the first step toward organizing the campaign. The meeting was held at the college on August 21. The chief purpose was to find out what these manufacturers and jobbers could do to aid in the movement. At this meeting a number of spray pumps were offered as prizes from various manufacturers, and the types of outfits for various size orchards were adopted. Suggestive talks were made by both college and factory officials.

The next step included an interview with the governor who issued a proclamation to the people of the state proclaiming December 9–15 as "Spray Your Orchard Week." The annual meetings of the Mississippi Retail Hardware Dealers Association and the Mississippi county health officers were attended at which resolutions were passed assuring their coöperation.

Publicity was given the campaign during the fall at the various fairs of Mississippi and neighboring states at which "Spray Your Orchard Week" booths were established and spraying demonstrations held. The Chambers of Commerce and Boards of Trade of the larger towns gave valuable publicity, as did the daily press and farm magazines. Some of the farm papers put on a special "Spray Your Orchard Week" issue.

The county agent was made the leader of the campaign in his county, and the home demonstration agent assistant leader. Arrangements were made whereby every agent in the state had a spray pump for this week. A personal visit was made to each county of the state before the campaign to assist in the organizing. The county health officer gave his services during the week to give talks on fruit and health at the demonstrations. The state superintendent of education requested the use of a specially prepared spray booklet in all of the schools of the state during spray week, and the agricultural high schools gave demonstrations in the school communities. The county superintendents of education gave their time during the week to the agents for short talks at demonstrations. The twelve thousand Mississippi club boys and the ten thousand club girls with their state leaders assisted materially with the campaign as did also the entire state extension force. The railroads loaned their agricultural agents for the week to assist in the work, and rendered other valuable assistance as did the bankers, rural clubs, nurserymen, state department of agriculture, and the experiment station and its branches. The hard-

ware dealers exhibited window displays of spray outfits, etc., during spray week. Posters, letter stuffers, and stamps on letters from the various departments of the college, announcing the campaign, also gave much publicity to the movement. For the agents, both men and women, making the best record during the week spray pump outfits were offered as prizes.

The campaign was opened on Sunday when the various ministers of the state used an outline sermon prepared by ministers of the respective denominations, which contained some reference to the campaign. In a systematic way spraying demonstrations and meetings were held in every community of each county of the state during the week under the direction of the county agent or his assistants. A chart was used at each demonstration discussing the fundamental principles of spraying and spraying operations, and some county official was usually present who made an address. A specialist was also on hand at a number of the meetings and demonstrations.

The results accomplished from this first campaign were amazing. Spray pumps could be found in every community of the state either owned by individuals or community clubs and each community had a decided knowledge of the San José scale, and means of controlling it. The scale infestation as a whole most certainly was materially decreased throughout the state. The sale of spray pumps and equipment in the state of Mississippi by one of the largest pump manufacturers in this country showed an increase of 37 per cent during 1918 as compared with the previous year. There was a likewise material increase in the sale of insecticides in the state, and during 1918 they could be found in practically every town in the state where they had not been for sale heretofore.

Such excellent results were obtained from the first campaign that it was decided to put on a follow-up campaign during the winter of 1918–19. Practically the same means of organizing were used in the second campaign as in the first, only the dates were changed to February 9–15. Louisiana had seen the value of such a movement, and decided to join us in our second campaign. The dates were moved forward so as to give the sister state sufficient time to organize.

The second campaign was equally as successful in Mississippi as the first. One manufacturer reports an increased spray pump sale in Mississippi of 40½ per cent during 1918–19 as compared with the previous year and 134 per cent increase over the sales in 1916–17, before the first campaign. Others report an increase of 50 per cent and better. One dealer of insecticides states that their sales are now a nice part of their business, whereas they were practically nothing prior to the first campaign. A well-known manufacturer of insecticides reports an increased sale since the campaigns from practically nothing to $5,000 per year.

PRESIDENT W. C. O'KANE: The next paper is by W. O. Hollister, on "The Distribution of Shade Tree Insects in 1919."

DISTRIBUTION OF SHADE TREE INSECTS IN 1919

By W. O. HOLLISTER, *Kent, Ohio*

This subject, the distribution of shade tree insects in 1919, is a very broad one for if every shade tree insect which appeared were mentioned this discussion would be very lengthy indeed. Only the most important pests are considered and the territory covered has rather definite limits, covering in a general way the country east of the Mississippi River and north of the Mason-Dixon line, but more especially that territory around the larger cities of Chicago, Cincinnati, Detroit, Cleveland, Pittsburgh, Washington, Philadelphia, New York, Newport and Boston.

The source of information is not entirely first hand. It was secured mostly from reports sent in by the experts of the company which I represent, men who had the opportunity of coming in personal contact not only with shade trees but with the insects themselves. The men sending the reports have had some training in entomology and considerable training in the care and preservation of shade trees. Their reports, as well as those from gardeners of private estates, were supplemented to a limited extent by reports from state entomologists. Twice during the season, the first of July and the first of October, a list of about forty insects was sent out with a request for information regarding their abundance, and from these reports, totaling about one hundred and fifty, this paper is compiled.

It would be difficult to say just what insect was most abundant or the one causing the most injury to shade trees this year. Judging from the reports which were received no insect appeared to be especially serious. Without question though, the most abundant insect was the aphid, and it was everywhere. The fruit grower with his systematic spraying and careful attention to his orchard should have no trouble in controlling these little pests but the shade trees are usually neglected and the aphids run wild. Few trees are immune from their attacks and many of our finest shade and ornamentals are hosts of one or more species. One very conspicuous aphid was the woolly beech leaf aphid, *Phyllaphis fagi* Linn., on the beeches, especially the copper beech, *Fagus sylvatica*, variety *purpurea*. The attention of the estate owner might have been called to the trouble by the shiny appearance of the leaves caused by the honey dew or by the whitened appearance of the underside of the leaves. Now it is probably true that with a few exceptions no one species of insect will kill a shade tree, still they

lower its vitality and make it susceptible to the attack of other insects or fungous diseases. Hence the importance of caring for shade trees even though the pest be small. There were numerous other aphids reported but they have been classed together with the exception of the maple phenococcus, *Phenococcus acericola*, which was quite conspicuous in northern Virginia. This species was also noticed in northern Ohio.

Of the scale insects found on shade trees this year the oyster scale, *Lepidosaphes ulmi*, was probably the most abundant. In nearly every section it was reported on ash, carolina poplar, willow and other shade trees. In many cases the limbs were coated over with these insects, so much so, that the men were handicapped when climbing because of the slippery limbs. The San José scale is not generally found upon shade trees other than fruit trees which may be growing in gardens or lawns. It is often found upon the mountain ash, and was so reported from Pittsburgh and Corning, N. Y. The pine leaf scale, *Chionaspis pinifoliæ*, was numerous at Detroit, in northern Ohio, Pittsburgh, Connecticut, and noticed at Albany, around New York, and Boston. The tulip scale, *Toumeyella liriodendri*, was noticed occasionally and was reported abundant from Washington to Philadelphia, in northern New Jersey, and numerous along the Hudson River and around Boston, and noticed in other places. The principal scale on the elm is the elm scurfy, *Chionaspis americana*. At Chicago, Pittsburgh, around New York and at Boston it was abundant. Another elm scale, *Gossyparia ulmi*, was plentiful near Poughkeepsie, N. Y., numerous at Albany, Pittsburgh, Cleveland, and Detroit and noticed in Connecticut and at Boston. The cottony maple scale, *Pulvinaria vitis*, is the worst scale on the soft maples and as these trees are planted in every section this insect is very common. Nearly every report mentioned this scale. At Chicago, Detroit, Pittsburgh, Baltimore, New York, and in Connecticut it was very abundant while it was more or less common around Boston, Philadelphia, Cleveland, and Cincinnati. The golden oak scale, *Asterolecanium variolosum*, was quite serious at Philadephia last spring.

None of the leaf eating insects were reported as especially destructive this year. The canker worms, however, were bad last spring in northern Ohio as well as at Detroit. At Cincinnati, Pittsburgh, around New York, and Boston they were also quite common, and noticeable in northern Virginia and in Maryland. The cottonwood leaf beetle, *Melasoma scripta*, was reported from Long Island and along the Hudson River. *Euvanessa antiopa* caterpillars were reported from Detroit and Boston. The bag or basket worms, *Thyridopteryx ephemeræformis*, were conspicuous in New Jersey at Red Bank, as well as south into Maryland and Virginia. They were also reported from

Cincinnati and from southern Illinois. This insect is common, of course, only in the southern limits of these observations. The black walnut caterpillars, *Datana integerrima*, were quite abundant at Detroit and Newport, R. I., and numerous at Chicago and Cincinnati. They were reported also from around New York, Baltimore and Pittsburgh. The elm leaf beetle is still with us, being reported abundant this year from Newport, eastern Connecticut, around New York, including Long Island and northern New Jersey, and numerous at Boston, Albany and at Cincinnati. The elm leaf miner was in evidence at Pittsburgh, Baltimore, Long Island and Boston and noticed at Detroit. The elm case bearer, *Coleophora limosipennella*, showed up in northern New Jersey, Long Island and along the Hudson River. In northeastern Ohio the fall web worm, *Hyphantria cunea*, seems to be on the increase. It was serious in Detroit, Pittsburgh, Cincinnati, northern New Jersey and along the Hudson River. At Philadelphia, Boston, Albany, and Chicago it was quite common. On Long Island and up the Hudson the locust leaf miner, *Chalepus dorsalis*, did some injury as well as working in Newport, Philadelphia, Baltimore, Pittsburgh, and Cincinnati. Only one caterpillar of the tussock moth, *Hemerocampa leucostigma*, was found at Kent, Ohio, where two years ago trees were defoliated. At Cleveland, however, they were quite conspicuous. They were also reported from Connecticut, Brooklyn, Wilmington, and Chicago as abundant and numerous at Boston, Albany, Long Island, Cleveland and Detroit. A few leaf eaters were reported feeding upon the conifers, but none of them were doing any apparent injury with the possible exception of the larch sawfly in northern New Jersey.

The insects which are most noticeable to our men and which are in many cases the most destructive are the borers. This term is generally applied to those forms which confine their depredations to the interior part of the tree, either the roots, trunk, branches, or twigs. Because of their internal operations their work is often not noticed until a tree is in a serious condition. With a few exceptions borers seem to prefer trees with a lowered vitality. The hickory bark borer, *Eccoptogaster quadrispinosus*, and the bronze birch borer, *Agrilus anxius*, are good examples. The former can kill a tree in less than twenty days. These pests are killing the hickories by the thousand every year although in the east it is reported that they are not as serious. Reports from around New York, Pittsburgh, Cleveland, and Detroit were that the beetles were very bad this year while at Newport, Baltimore, and Chicago they were quite numerous. The bronze birch borers are gradually killing the white birches. They were reported serious from northern New Jersey, quite noticeable from Newport, Poughkeepsie, N. Y.,

and Cleveland, and present at Boston, Detroit, and Chicago. The carpenter borer, *Prionoxystus robiniæ*, is a steady worker, being plentiful this year around New York, Pittsburgh, and Detroit, and noticed at Boston, in Connecticut, Baltimore, Cleveland, and Chicago.

As a bark borer, *Eccoptogaster multistriata*, on the elm was reported a number of times from along the Hudson River and in northern Virginia. At Boston, Cleveland, Detroit, and Chicago, these borers were quite numerous. The locust would be a more valuable tree if it were not for the borer, *Cyllene robiniæ*, which this year was quite conspicuous at Newport, around New York, and especially on Long Island, at Philadelphia, Baltimore, Pittsburgh, Detroit, and Cincinnati. The locust twig borer, *Ecdytolopha insiticiana*, was reported from Long Island, northern Virginia and near Cleveland. The leopard moth, *Zeuzera pyrina*, was found only at Boston, Newport, and Long Island. The sugar maple borer, *Plagionotus speciosus*, was quite abundant in northern New Jersey and along the Hudson as well as in Connecticut, and down the coast to Philadelphia, at Pittsburgh, and Cleveland. While at Boston and Chicago evidence of its work was found. The maple sesian, *Sesia acerni*, seems to prefer the soft maples and is usually found hindering the growth around wounds. It was quite common in Connecticut and along the Hudson, at Philadelphia, Detroit, and Chicago.

The twig pruner, especially *Elaphidion villosum*, is often injurious to a tree but usually the objection is the unsightly appearance of the tree or the lawn beneath. From Albany to Washington they were very conspicuous, as well as at Newport, Detroit, and Chicago. Around Chicago the two lined chestnut borer, *Agrilus bilineatus*, was injuring oaks this year. It was also reported from Albany and Long Island. One of the most common insects found in cavities in trees is the black carpenter ant, *Camponotus* species. Give them an opening and in they will go and by making tunnels and galleries, they quickly weaken a tree structurally. They were reported abundant from Boston to Baltimore and numerous from Pittsburgh to Chicago. The red spiders, *Tetranychus* sp., seem to be causing increasing injury to oaks, maples, and beeches. They were fairly abundant in every section.

This, then, in a brief way, is the distribution of the shade tree insects in 1919.

DR. L. O. HOWARD: I would like to ask Mr. Hollister, if the where canker worms were abundant, he found they were eaten by birds.

MR. W. O. HOLLISTER: That was noticed at Kent, Ohio.

PRESIDENT W. C. O'KANE: The next paper is on the "Control of the Codling Moth, with Spray-Gun, Rod, and Dusting Method—Three-Year Tests," by LeRoy Childs.

THE CONTROL OF THE CODLING MOTH WITH SPRAY-GUN, ROD AND DUSTING METHOD

By LEROY CHILDS, *Hood River, Ore.*

(Paper not received)

Adjournment.

Scientific Notes

European Corn Borer in Broom Corn. Early in February, 1920, a shipment of broom corn infested by the European corn borer was received at New York from Venice, Italy. This consignment was intercepted by Mr. H. B. Shaw, inspector for the Federal Horticultural Board. The broom corn originated in the territory of Venetia, Northern Italy, and consisted of 97 bales, each weighing about 200 pounds.

Upon examination it was found to be infested to a considerable degree, the percentage being somewhere between 1 per cent and 5 per cent of the stalks. Large, nearly full grown larvæ as well as pupæ in a live and healthy condition were found. These larvæ were determined by Mr. Heinrich, of the U. S. National Museum, as *Pyrausta nubilalis* Hubn.

The broom corn stalks were about 36 inches long, of which at least 15 inches consisted of the butt. The larvæ were found throughout the length of this butt and in most instances had extended their tunnels into the extreme upper tip of the terminal internode, beyond the point where the hurls are given off.

This incident obviously strengthens the belief already held that broom corn was the host in which the European corn borer gained access to this country, and apparently established the evidence submitted by Mr. Harrison E. Smith, in his paper appearing in the next number of this JOURNAL entitled, "Broom Corn, the Probable Host in Which *Pyrausta nubilalis* Hubn. Reached America."

W. R. WALTON.

Aphids and Coccids. Species of both are of considerable economic importance. As many of the American species are identical with or closely allied to European, it is doubtless desirable to have material of European species for comparison ready at hand. From the correspondence that I have had with a number of American colleagues since the conclusion of the war, I see that this desire actually exists. Doubtless the study of aphids and coccids will be considerably advanced in the presence of such comparison material. As I have during recent years extended my studies also to these insect groups, it will be no difficult matter for me to satisfy these desires. I wish to announce that I will gladly undertake to furnish such material to interested American colleagues and by means of this circular I am addressing a call to the Experiment Stations and specialists for the attention of those that wish to get in touch with me. The distribution of the material will be entirely gratis. By way of reciprocity, I should like to have the stations place my name on their regular mailing lists of their publications.

F. SCHUMACHER,
Charlottenburg-Berlin IV, Mommsenstr. 53–54, Germany.

Note on Eriopyga incincta Morr. A cutworm-like caterpillar, later identified as *Eriopyga incincta* Morr., was abundant at Wichita, Kan., during the spring of 1918. It was not found at other Kansas points visited, nor was it observed among cutworms found during three previous years at Wichita. Cutworm injury developed suddenly, and was a source of complaint from about April 10 until late in May. *Feltia subgothica*, usually the commonest species, was scarce except in a few spots where favorable conditions existed. *Eriopyga incincta* was the most numerous species, and seemed to be responsible for a great deal of injury. It was found in great numbers in small areas in alfalfa and about the edges of gardens, and in one instance 25 larvæ were taken in a bed of pole beans in which the plants were just coming up. The larvæ were not observed actually feeding, but there was considerable cutworm injury in that vicinity and it is probable that both alfalfa and beans were affected. The specimens obtained were hidden in surface trash or loose soil, in just such places as are most affected by cutworms.

The larva is clean-looking and distinctly marked, in sharp contrast to the dull appearance of *Feltia subgothica*. It is a smooth, glistening caterpillar, dark gray to black, with an irregular brown mid-dorsal stripe. The ventral surface is lighter, the tubercles glistening black.

The pupa is of the ordinary cutworm type, and of a reddish brown color. It is slightly duller in luster, and more reddish in color, than most cutworm pupæ.

Larvæ were half-grown or larger by April 15, and full-grown in May. A larva was seen preparing to pupate May 20. A few pupæ were present May 27. About one-third of those in the field, and two-thirds of those in the insectary, had pupated June 1. Nearly all were pupæ by June 8, all by June 15. The first adult appeared August 19, but no more emerged until September 11. From September 11 to 20, 22 adults emerged; from September 21 to 26, 17 emerged. No adults appeared after this date. The moths were confined in a cloth-covered cage, and food supplied, but no eggs were deposited. The pupal period is from three to four months in length, and includes the hot season. The length of the egg and larval stages, and the hibernation stage, are not known. From the size the larvæ had attained in April, it seems probable that the species hibernates in the larval stage.

F. M. Wadley, *Muscatine, Iowa.*

Two Rhynchophora Found Feeding in Sweet Potatoes. During the past year many reports have come from various parts of this state (Louisiana) in regard to insect damage done to sweet potatoes while in the soil. Most of this damage is supposed to be caused by the sweet potato weevil (*Cylas formicarius* Oliv.) but two cases which have come to my notice were caused by *Xyleborinus pecanis* Hopk. and *Platypus compositus* Say.

In the case of the former the beetles made straight, clean cut burrows, which were usually from one to two inches long, whereas in the case of the latter the burrows were partly filled with material the exact nature of which was not noted.

Fields or patches of sweet potatoes which are infested with the above beetles are usually surrounded by trees, adjacent to trees, on at least one side, or on newly cut-over land.

Determination of beetles by Dr. A. D. Hopkins.

O. W. Rosewell,
Louisiana State University.

Anasa Tristis DeG. (Hemiptera) Feeding on Leaves and Fruit of the Fig Tree. On August 16, 1919, while walking through a lane between two farms, located about two miles from New Roads, La., I noticed that the leaves on a row of fig trees along

one side of the lane appeared blotched and yellow. A closer examination showed that there were numerous adult specimens of *A. tristis* DeG. as well as various other stages of this insect. On many leaves there were from five to ten specimens. There were five nymphs feeding on a single fig.

From the above observation I concluded that this was a real infestation of fig trees by *A. tristis* DeG., because there were no cucurbit vines within one hundred yards.

O. W. Rosewall,
Louisiana State University.

To Keep Out Cane Butterfly. Because of the financial loss suffered by sugar centrals in Porto Rico from the rapid spread of the cane mosaic (yellow stripe) disease, strong efforts have been made by them to secure permission to introduce seed cane from Santo Domingo, with the hope to overcome the disease. Such a course would result in grave danger of introduction of the Santo Domingo cane butterfly, *Calisto archebates* Men., a pest whose larvæ literally strip the leaves from hundreds of acres of sugar cane in that island during the winter months. The introduction of this pest into Porto Rico, where already the May-beetles and weevil root-borer (*Diaprepes spengleri* Linn.) cause great annual loss to cane, would be a calamity beyond hope of reparation.

Federal quarantine regulations against sugar cane introduction do not, unfortunately include protection to Porto Rico, and the insular quarantine law permits introduction of plant products for manufacture or industrial purposes in such phraseology as to make difficult the inclusion of sugar cane under the ban of strictly prohibited products. However, the quarantine experts of the Insular Experiment Station took the matter in hand, presenting many arguments against the proposed cane importation and bringing all possible pressure to bear against the action, with result that the centrals of the island decided to give up the idea of introducing seed cane, and to use instead the cultural methods of combating the disease that have been advised by the station experts

E. Graywood Smyth.

The Porto Rico Mole-Cricket in South Carolina and Florida. The Porto Rico mole-cricket or "changa," which has been established in Georgia for a number of years where it is a troublesome pest, has made its appearance recently in South Carolina and Florida.

August 13, 1919, Mr. John C. Burrowes, Jacksonville, Fla., complained of this species, stating that it was known as a "cricket mole" and was playing havoc on some of the greens and fairways of the Florida Country Club. Carbon disulphid and arsenate of lead had been employed as remedies but without success. September 4 specimens were sent for identification which proved to be *Scapteriscus vicinus* Scud. They were obtained by plowing up the putting greens that the insects had destroyed. When the outbreak was first reported poisoned baits such as used for cutworms and grasshoppers were advised, and later Mr. B. L. Boyden investigated the infested region and reported that these baits were very successful.

Later in the same month a number of complaints were made of mole-crickets in the vicinity of Charleston, S. C., and the infestation was investigated by Mr. W. A. Thomas, working under the writer's direction. This proved to be the same species. It is known locally as "ground puppy," a name which is used for this and the short-winged mole-cricket in Georgia and in southern Florida, respectively. In a report on its occurrence rendered by Mr. Thomas October 21, he stated that the infestation covers an area of about 12 square miles and that it is spreading from year to year,

comprehending Charleston and much of the adjacent area of James Island and a considerable scope of the mainland across the Ashley River from Charleston. The truckers claim that the insect had appeared about five years ago or about 1914 and had rapidly increased in destructiveness until some truckers had been forced to abandon some of the chief crops of that region, among them spinach, carrots, beets, and lettuce. The cabbage industry is being seriously threatened at the present time. Poisoned baits were used as in the case of the Florida infestation, but without success. The failure can be attributed to the lateness of the season, as the baits were not applied immediately and the insects did not seem to feed at all during the latter part of October and later.

In looking over the correspondence of the Bureau of Entomology, the writer finds that this species was reported in two other localities in South Carolina in earlier years. October 1, 1915, Mr. T. R. Hamlin, Mount Pleasant, S. C., sent specimens, stating that the insect was a pest in seed beds and that he had been fighting a losing game with them for years. "Unlike our common destructive insects, the mole-crickets," he writes, "work in the open and infest the well-cultivated seed beds, causing during two or three previous seasons a 60 per cent loss." They were also described as destroying the tender shoots. The specimens in this case were identified by Mr. A N. Caudell. March 1, 1917, Mr. R. H. Adams, Navy Yard, Charleston, S. C., reported this species feeding on seeds and young plants in that vicinity, but the specimens sent were immature and a positive identification could not be made at that time.

This species, it should be added, is best known in literature as *Scapteriscus didactylus* Latr.

F. H. Chittenden,
Bureau of Entomology, U. S. Department of Agriculture.

JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

FEBRUARY, 1920

The editors will thankfully receive news items and other matter likely to be of interest to subscribers. Papers will be published, so far as possible, in the order of reception All extended contributions, at least, should be in the hands of the editor the first of the month preceding publication. Contributors are requested to supply electrotypes for the larger illustrations so far as possible. Photo-engravings may be obtained by authors at cost The receipt of all papers will be acknowledged —Eds

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This issue has been greatly delayed by unprecedented combinations of illness in the printing, not editorial office, abominably slow mail service and snow blockades following an unusual delay in the completion of the proceedings.

If nothing more were taken into account than the aid in defending farmers against insect pests, the appropriations made by the different states for the support of such efforts could but be regarded as very profitable. More than this, the agencies devoted to investigation and teaching have constructive value in opening the way, slowly to be sure, for more effective methods of handling the vast agricultural resources of the country. For these reasons careful consideration should be given by entomologists to what are their real needs if their activities are to develop in accordance with the demands made upon them. Moreover, a proper balance should be maintained between such efforts as investigation, instruction and inspection that they may proceed symmetrically. The foregoing remarks serve to introduce the question if the work of inspection and certification of insecticides should not receive more serious attention by entomologists. There is no escape from the fact that the field of insecticides is being energetically exploited in an increasing degree, with the result that there is now an amazing assortment of spraying materials on the market. The enactment of measures providing for more complete analyses and clearer explanation of the data than is now done, should prove beneficial to both manufacturers and farmers. Also, with conservative inspection

and emphasis placed on the educational features of the law in its administration, there should come about a marked improvement in the accuracy of the statements in advertising circulars and shipping tags. Surely, men with fundamental training in the subjects of entomology and chemistry have a large opportunity, and fortunate indeed is the entomological staff that is able to command their services. The need of research in the field of insecticides is too evident to be denied. The science which should guide workers in this endeavor is only in its infancy, and the most important problems are still to be solved.

P. J. P.

Compensation has very properly received considerable attention of late. It is a vital and most important problem and unless it is solved satisfactorily, there will invariably be a lowering of professional standards. The latest contribution along this line is an anonymous circular distributed by a group of younger entomologists. This details the unfortunate situation of a number of the younger men entering the work, who because of their love of science were content to accept inadequate compensation at the outset in the hope of material increases later. It is presumable that most young entomologists look forward to obtaining one of the more responsible positions, possibly fifty in number in this country, and are willing to take some chances. There are now over five hundred and fifty members of the Association, a large proportion being well-trained and within certain limits capable of filling any position. We should note in this connection that the eight past presidents attending the St. Louis meeting had an average age of 56 years, an average term of service of 31 years and the larger proportion of them would not rank as old men. These figures indicate an extended period of official activity, particularly in this class. In other words, there are many candidates and relatively few good positions with comparatively infrequent changes and capable assistants are absolutely necessary to a proper discharge of the numerous responsible duties falling to that class of men. Inefficient assistants reflect upon the chief and in the long run upon the entire service. Students should not be urged to enter entomological work without some idea of the actual prospects and those in administrative positions must see the imperative need of adequate compensation if satisfactory standards are to be maintained. Research for the sake of research is praiseworthy. It is belittling the spirit of justice and equality, supposedly American virtues, to expect service out of all proportion to the compensation and opportunities offered and this latter has been altogether too frequent in the last few years.

Obituary

MARIA E. FERNALD

"A Catalogue of the Coccidæ of the World," published as Bulletin 88 of the Hatch Experiment Station of the Massachusetts Agricultural College, with its 360 pages of technical names and citations, is a most fitting memorial of the scientific activities of Mrs. Fernald, who was gathered home October 6, 1919, having been permitted to live for a full four score years. Many of the entomologists trained at the Massachusetts Agricultural College will remember the cosy home on Hallock Street, a delightful center for both social and scientific activities.

Mrs. Fernald was born at Monmouth, Maine, May 24, 1839, the daughter of Ebenezer and Betsy (Torsey) Smith. She was graduated from the first class of the Maine Wesleyan Seminary and Female College, Kent's Hill, Maine, where she afterwards served as preceptress. She was married to her talented husband, Charles H. Fernald, August 24, 1862, and the couple lived in Litchfield, Houlton and Orono, Maine, before coming to Amherst in 1886.

Mrs. Fernald was deeply interested in scientific work and in the late seventies began a card catalogue of the Tortricidæ which became so useful that it was later extended to include all insects and one section was developed into the catalogue of the Coccidæ named above. This was only a portion of Mrs. Fernald's activities. She was a member of the Amherst Woman's Club, and took an active part in the social life of both the community and college. She is survived by her husband, Professor Charles H. Fernald; her son, Professor H. T. Fernald, and three grandchildren. E. P. F.

Current Notes

Conducted by the Associate Editor

Mr. Grover C. Matthews has been appointed assistant professor in beekeeping at the University of Minnesota.

Mr. John R. Eyer has been appointed instructor in economic entomology in the Pennsylvania State College.

Mr. George B. Newman has been appointed assistant in entomology at Purdue University and the Indiana Station.

The Ontario County (N. Y.) Beekeepers' Association arranged to hold a convention at Canandaigua, N. Y., on January 13.

Mr. W. E. Jackson, assistant entomologist of the Texas College and Station, has resigned to enter commercial work.

Mr. Julius W. Sauer has been reappointed assistant entomological inspector, Bureau of Entomology, with headquarters at Kingsville, Tex.

The annual convention of the National Beekeepers' Association was held at the Hotel Statler, Buffalo, N. Y., March 1 to 3.

The National Conference of delegates representing beekeeping organizations was scheduled for January 6 to 9 at the Muehlenbach Hotel, Kansas City, Mo.

Messrs G. W. Barber and D. J. Caffrey are now engaged in the preparation of a manual of Cereal and Forage Insects, which it is hoped will be completed in the near future.

The annual meeting of the Missouri Apicultural Society will be held the third week in January at the University of Missouri, Columbia, Mo.

The Wayne County (N. Y.) Beekeepers' Society held its third annual meeting at the Grange Building, Newark, N. Y., on January 30.

The annual meeting of the Washington State Beekeepers' Association was held in the hall of the Chamber of Commerce, Seattle, January 22 to 24.

The following resignations are announced in the Bureau of Entomology: C. F. La Grone, Baton Rouge, La.; W. B. Williams, C. H. Williams, boll weevil force.

A conference of federal and state workers employed in controlling the gipsy moth was held February 3, at 10.00 a. m., in room 408, State House, Boston, Mass.

Dr. Roger C. Smith of the United States Bureau of Entomology has resigned to accept the position of assistant professor of entomology in the Kansas State Agricultural College.

Mr. H. E. Loomis, assistant entomological inspector, Bureau of Entomology, who has returned from service in the Marine Corps, has been reappointed with headquarters at Macclenny, Fla.

Professor Herbert Osborn, Ohio State University, was elected a member of the executive committee of the American Association for the Advancement of Science, at the St. Louis meeting.

Dr. A. L. Quaintance, Bureau of Entomology, made an extended trip to the Pacific Coast, visiting various field laboratories attached to his division. He has now returned to Washington.

Mr. C. S. Anderson, of Harrisburg, Pa., was appointed September 1 to the Bureau of Entomology as entomological preparator for duty on the European corn borer investigations at Arlington, Mass.

Dr. W. J. Holland, director of the Carnegie Museum, Pittsburgh, Pa., gave the annual address before the Entomological Society of America at St. Louis on the evening of December 30, 1919.

Mr. Thomas H. Jones, entomological assistant, Bureau of Entomology, is in Florida, where a new station will be established for the investigation of the insects injurious to truck crops in that state.

Mr. C. H. Popenoe, Bureau of Entomology, entomologist in truck crop insect investigations, has spent the month in visiting the western stations of that branch, with particular attention to the Central Pacific states.

Mr. W. B. Wood, Bureau of Entomology, who has been assisting Dr. N. E. McIndoo in connection with insecticide investigations the past season, has been transferred to

the Federal Horticultural Board, and assigned to duty in the Plant Quarantine Greenhouse.

The New Jersey Beekeepers' Association held its annual meeting at Trenton N. J., January 15 and 16. Dr. E. F. Phillips, and E. G. Carr, secretary of the association, addressed the meeting.

Mr. Neale F. Howard, specialist in insects as carriers of plant diseases, has been reappointed in the division of truck crop insect investigations, Bureau of Entomology, and has established headquarters at Bowling Green, Ohio.

The Ontario Agricultural College at Guelph, Ont., held its tenth annual Short Course in Apiculture January 12 to 24 Messrs. F. E. Millen and George H. Rea were among the speakers

Mr. John E. Graf, Bureau of Entomology, has returned to his headquarters at Macclenny, Fla , after a protracted visit at Ocean Springs, Miss., in connection with sweet-potato weevil eradication and experiments in control measures.

Mr. F. J. Brinley has been appointed by the Bureau of Entomology, truck crop insect investigations, to take charge of the field station at Greeley, Colo., a position made vacant by the resignation of A E. Mallory.

Mr. M. D. Leonard and Dr. Robert Matheson, of Cornell University, have been granted appointments as field assistants of the Bureau of Entomology for special work in connection with the European corn borer investigations at Arlington, Mass.

The fifth annual meeting of the Tennessee State Horticultural Society, Nurserymen's Association, and Beekeepers' Association, was held at Nashville, Tenn., December 9 to 11, 1919. Professor G. M. Bentley is the secretary-treasurer of each of the three associations.

Dr. L. O. Howard, chief of the U. S. Bureau of Entomology, and for twenty-two years permanent secretary of the American Association for the Advancement of Science, was elected president of that association at the St. Louis meeting.

The New York State Association of Beekeepers' Societies held its annual meeting at the Joseph Slocum College of Agriculture, Syracuse University, February 3 and 4. Among the speakers were Dr. Burton N. Gates, George H. Rea, and E. G. Carr.

A conference on the European corn borer was held at Hartford, Conn., February 12, in connection with Farmers' Week. Invitations were sent to the official entomologists and commissioners of agriculture of the New England states, New York and New Jersey.

Dr. Burton N. Gates, formerly assistant professor of entomology in the Massachusetts Agricultural College, Amherst, Mass., who resigned to accept a position at the Ontario Agricultural College, Guelph, Ont., is now living in Worcester, Mass., and is again in charge of apiary inspection in Massachusetts.

Mr. A. L. Ford represented cereal and forage insect investigations of the Bureau of Entomology at the International Hay and Grain Show, Chicago, Ill., during the week of November 29 to December 6. Mr. Ford prepared and set up the exhibit of cereal and forage insects, which was exhibited at the show.

Mr. E. J. Hoddy severed his connection with the Bureau of Horticulture, Department of Agriculture of Ohio, on November 30, to accept a position with the Louisville and Nashville Railroad Company with headquarters at Knoxville, Tenn. Mr. Hoddy succeeds Mr. W. E. Evans who has entered private commercial work at Eustis, Fla.

Mr. George N. Wolcott, who was recently engaged to handle the entomological phases of the coöperative work between the Bureau of Entomology and the Bureau of Plant Industry relating to the possible insect transmission of the sugar cane mosaic disease, sailed for Porto Rico on November 24, to take up the work there.

A course for commercial beekeepers was held in connection with the annual meeting of the Ohio Beekeepers' Association, during Farmers' Week at the Ohio State University, Columbus, Ohio, from January 26 to 30. This course is in charge of Dr. E. F. Phillips and Mr. George S. Demuth of the Bureau of Entomology.

Mr. Melvin E. Wyant, a recent graduate of the Ohio State University, has been appointed a deputy inspector in the Bureau of Horticulture of the Department of Agriculture of Ohio to succeed Mr. Richard Faxon, who resigned some time ago to accept a position in the insecticide department of the Glidden Company of Cleveland, Ohio.

Major L. H. Dunn has recently resigned from the United States Army, having served for some time in France, where he was in charge of delousing men and equipment. He has just accepted a position as entomologist to the League of Red Cross Societies with headquarters at Geneva, Switzerland, though he expects that most of his work will be in Poland.

R. R. Parker, Assistant State Entomologist of Montana, has been appointed a member of a North American commission of three experts to investigate the spread of typhus fever in Russia and Poland. He sailed from New York about January 15 with the understanding that he was to be released in April to resume his work in this country.

Wilmon Newell, plant commissioner of Florida, was tendered a complimentary dinner at Gainesville, January 12, by a number of his associates, in honor of his election as President of the American Association of Economic Entomologists. The following institutions were represented: State Plant Board and Board of Control, Faculty of the University of Florida, Staff of the Experiment Station, Staffs of the General Extension Division and of the Agricultural Extension Division of the University of Florida and Staff of the State Plant Board. There were 54 present, Hon. J. B. Hodges, chairman of the State Plant Board and Board of Control acted as toastmaster.

According to the Experiment Station Record, announcement was recently made in Parliament of a change in policy in 1918 regarding research in entomology and plant pathology through public funds. These subjects were originally allocated to the University of Manchester and the Royal Botanic Garden at Kew, respectively, with grants from the Development Fund for their support. In 1918, however, the Development Board decided that all research in plant diseases, whether due to insects or fungi, should be concentrated at a single phytopathological institute at Rothamsted, where also the board's scientific advisory staff in the subject would be stationed. Accordingly the staff at Manchester and a portion of the mycological staff at Kew were transferred to Rothamsted. A grant of $5,000 per annum was, however, continued to the University of Manchester to maintain certain phases of its entomological work and also to take up work in mycology there.

An enjoyable dinner was held by the entomologists at the St. Louis Athletic Club on New Year's night. This was the first time that the entomologists have held a dinner, and it is likely to become an annual event. Eight ex-presidents were seated together at the table with the president, Professor W. C. O'Kane, who called attention to the fact that their combined age was 452 years, and that their combined period of

service amounted to 252 years. There was no formal program, but Dr. Howard was asked to take charge of ceremonies, and he read a very interesting letter, both pathetic and humorous, from Professor Josef Jablonowski, of Budapest, Hungary, then called upon each of the following entomologists for a few remarks: Professor S. A. Forbes, Urbana, Ill.; Professor Herbert Osborn, Columbus, Ohio; Dr. E. P. Felt, Albany, N. Y.; Dr. W. E. Britton, New Haven, Conn.; Mr. C. L. Marlatt, Washington, D. C.; Professor P. J. Parrott, Geneva, N. Y.; Dr. E. D. Ball, Ames, Iowa, and Mr. Wilmon Newell, Gainesville, Fla.

A conference of entomologists to discuss the European corn borer situation was held at the Hotel Statler at St. Louis, on the evening of January 1, 1920, on invitation of Mr. C. L. Marlatt. Certain entomologists in attendance laughingly referred to this conference as a celebration of the twentieth anniversary of the reading of Mr. Marlatt's paper, "The Laissez-Faire Philosophy Applied to the Insect Problem." Though no very definite action resulted from this conference, it cannot be said to be of no benefit, as the varying viewpoints were explained and discussed. The following were present: R. H. Allen, E. D. Ball, G. M. Bentley, S. W. Bilsing, W. E. Britton, A. F. Burgess, E. C. Cotton, G. H. Dean, E. P. Felt, W. P. Flint, S. A. Forbes, S. B. Fracker, P. A. Glenn, L. Haseman, T. J. Headlee, J. S. Houser, E. G. Kelly, Wilmon Newell, W. C. O'Kane, Herbert Osborn, P. J. Parrott, A. G. Ruggles, J. G. Sanders, Franklin Sherman, Jr., M. H. Swenk and W. R. Walton.

It will be of interest to members of the Association of Economic Entomologists to learn that Dr. Paul Marchal, of Paris, has recently been elected member of the *Academia dei Lincei* of Rome and of the Academy of Sciences of Brussels It should be a matter of pride to all entomologists, and especially to economic entomologists (for Doctor Marchal is distinctly an economic entomologist, and is, by the way, a foreign member of this Association), that these great honors should have been conferred upon one of their number. It is one of the rapidly accumulating evidences of the esteem which workers in entomology are gaining in the minds of men working in other branches of science. This news will be especially agreeable to the American entomologists who had the pleasure of meeting Doctor Marchal during his visit to the United States in the summer of 1913.

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Proceedings of the Thirty-Second Annual Meeting of the American Association of Economic Entomologists

(Continued from p. 147)

Afternoon Session, Thursday, January 1, 1920, 12.45 p. m.

President W. C. O'Kane: The first paper on the program is "Features of the Codling Moth Problem in the Ozarks," by Dwight Isely and A. J. Ackerman.

SOME FEATURES OF THE CODLING MOTH PROBLEM IN THE OZARKS[1]

By Dwight Isely and A. J. Ackerman, *Bureau of Entomology*

A number of features of the codling moth problem in the Ozarks vary quite widely from its usual aspect in most of the apple regions of the United States. The relatively southern latitude of the Ozark region with its long growing season gives time for a larger number of broods than in regions farther north. Its inland situation and distance from bodies of water which produce equalizing effect upon temperature is probably responsible for the comparatively erratic seasonal history. The large number of broods and the fact that two of these broods, moths of the first and second, and immature stages of the second and third, occur during the heat of summer (a condition favorable to extraordinary prolificacy) produces an infestation of greater severity

[1] This paper is based on studies of the life history and control of the codling moth conducted during the seasons 1918 and 1919 at Bentonville, Ark., under the direction of Dr. A. L. Quaintance. The Bureau of Plant Industry represented by Mr. Leslie Pierce coöperated in spraying experiments. Mr. F. L. Wellman assisted the writers in routine work during both seasons.

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than is the rule in most fruit regions. These features of the codling moth problem, abundance, the variations in seasonal history, and the remedial measures necessary, are the subject matter of this paper. Particular attention is given to conditions differing from those reported by Jenne for 1907 and 1908. It is probable that similar conditions to those mentioned below are found in the fruit regions of southern Illinois, and of the Arkansas Valley in Kansas, whose geographical position in a general way resembles that of the Ozarks.

Abundance

The extent of loss to the apple crop in the Ozarks due to codling moth injury is very frequently underestimated by entomologists not familiar with this region. This is due in part to the fact that the codling moth apparently was not a particularly serious problem when experimental work was previously carried on here by the Bureau of Entomology in 1907 and 1908. In 1907 on the unsprayed check trees in the experimental orchard Jenne found only 34 per cent of the apples infested with "worms," and a very satisfactory control was secured on the sprayed plats. However, when the writers first came to the Ozarks they found the situation very different. There were many growers who said that they despaired of ever seeing the codling moth controlled and that they expected that at least 50 per cent of their apples would be infested by "worms" annually in spite of five or six spray applications.

The general report was that the codling moth problem had gradually become serious, but had been acute only the last few years. One was left to assume that this changed status of the pest was due to the more intensive development of the apple industry in this region or to the gradually cumulative effect of inefficient remedial measures.

Whatever the cause, the codling moth problem was found to be very serious. In 1918, in the check plat of an experimental orchard, 72.67 per cent of the apples were infested. This percentage does not indicate the full severity of the infestation, for in making counts all dropped fruits were included. Much of this fruit, which had been attacked by scab or had not been pollenated, fell early in the season before it had opportunity to be attacked by codling moth. The fruit which fell late in the season and that which was harvested was practically 100 per cent infested. In addition, more than one worm per apple was the rule rather than the exception with the apples that remained on the trees late in the season. One apple was noted that had been attacked by as many as eleven worms. In addition to the unsprayed check there were a large number of orchards dusted in 1918 and nearly all of these and a few that had been sprayed five and

six times showed as high or nearly as high an infestation as the check. To be sure, in these sprayed orchards the work had not been as thorough as was possible but in some it had been thorough enough to have controlled apple scab in a bad scab year.

The infestation for the season of 1919 was less severe. Fruit from the check plats in the experimental orchards was only 47.55 per cent infested, and the "extra worms" per apple were much less numerous. There were practically no dusted orchards in the region this season.

In 1917 no experimental work was conducted in the Ozarks. However, one of the writers was present during apple harvest and he found the codling moth not generally as injurious as it became the following season, but in some orchards the infestation ranged from 50 to 70 per cent.

The above data on abundance of codling moth during three seasons applies to the majority of orchards in this region. However, there are occasional orchards in which codling moth injury is comparatively light and in which the apparent immunity is not due to the effective application of remedial measures, but must be charged to natural conditions. These orchards are usually isolated and often quite distant from the main fruit growing sections. In some instances these low infestations are directly attributable to the loss of a crop the previous season because of frost injury or poor care. Conversely the most heavily infested orchards are regular bearers and in the heart of the fruit section.

Seasonal History

The seasonal summary which will be given herewith is based on insectary records which were checked up by band records and field observations. The rearing methods employed in the insectary were for the most part the same as those usually followed in the Bureau of Entomology and have been previously described. Battery jars were used for moth emergence, oviposition, and rearing of larval and pupal stages. Larvæ were allowed to spin cocoons in the standard "pupa-sticks," and jelly tumblers were used for incubation. Our methods differed from the usual as follows: Records of moth emergence and pupation of material in battery jars were checked up by records of material reared in wire cloth cylinders, which were kept both in the insectary and suspended around a tree trunk in the insectary yard. Oviposition from which incubation records were to be made was secured on pieces of dry twigs about two inches long. These seemed to us to have the advantage over leaves in that the latter when drying injured a percentage of the eggs. Paper was substituted for cheese cloth in making covers for the battery jars, when it was desired to prevent evaporation.

All larvæ upon which records of the overwintering brood were based were collected in the fall. The number of individuals used to determine the duration or time of occurrence of any stage was made to correspond, as far as possible, with the degree of variation to be expected and the economic importance of the phenomena in question. As for instance the period of spring emergence of moths is of first importance and is exceedingly variable, and for this it was aimed to procure over 3,000 overwintering larvæ. On the other hand the duration of the incubation period in midsummer is relatively constant and of little economic importance and records of 20 to 30 eggs per day were all that were attempted. To check up insectary records larvæ were collected under bands at intervals of three days in two orchards in 1918 and in three orchards in 1919.

During the first season of the writers' residence in this region, that of 1918, there were three full broods and a partial fourth brood of codling moth larvæ. Previous records have shown three broods for this region. As far as the writers are aware four broods are recorded from only one other state, New Mexico. The season of 1918 was very favorable to codling moth development, the summer as a whole and month of August in particular being remarkable for high temperatures. During the heat of summer all stages were passed rapidly.

The record of emergence, for this season, of the overwintering brood of codling moth extended from April 29 to June 3, and records of hatching of first brood larvæ from May 17 to June 13. The earliest first brood moths were secured June 15 and the first second brood larva, June 25. From this date until the early part of October the second and following broods continued hatching daily. Moths of the second and third broods began emerging July 27 and September 12 respectively, and their offspring, the larvæ of the third and fourth broods, began hatching August 4 and September 23 respectively. The second and third, and third and fourth broods overlapped to such an extent that it was impossible to separate them even in a general way either by field observations or band records. Most larvæ spinning cocoons after September 1 entered hibernation. Harvest of Jonathan apples was nearly over at this time and harvest of Ben Davis started by September 15. As a result many undeveloped larvæ of the third and nearly all of the fourth brood were carried out of the orchard with the fruit.

The feature of the seasonal history of the codling moth in 1919 was the length of the period between the beginning of emergence of overwintering moths and the beginning of hatching of larvæ in economic numbers. The earliest record of moth emergence was April 20 and by the middle of May nearly half of the brood had emerged. The first

record of hatching of larvæ was May 13 but until May 28 hatching both in the insectary and in the field appeared to be negligible. The general accuracy of these records was confirmed later by collections of larvæ from bands.

This long period of 38 days between the emergence of the first moth and hatching of larvæ in economic numbers was, no doubt, due to relatively warm weather during the early part of April which advanced the emergence of moths, followed by a succession of cold waves during the first three weeks of May which retarded or altogether prevented oviposition until about half the overwintering brood of moths had died. During the last week of May with the return of warm weather reproduction progressed rapidly. As a result practically all of the first brood larvæ were progeny of this second half of the overwintering brood of moths. The total period of emergence of overwintering moths was nearly two months, from April 20 to June 18, while the bulk of the resulting larvæ were hatched within three weeks beginning May 28.

The development of the two following broods was entirely regular except that the early part of the second brood was very light and practically negligible as might be expected following the peculiar development of the first brood. Both second and third broods were about a week later in appearing than they had been the year before. No records of a fourth brood were secured. The earliest record of a first brood moth was June 24 and of a second brood moth August 2. Larvæ of the second and third broods began hatching July 2 and August 12 respectively. As during the previous season both of these broods were present during the season of highest temperatures. While the second and third broods overlapped so that the hatching of larvæ was continuous from July until about October 1, the close of the season, the slackening of activity between broods was quite evident from band records. Larvæ began hibernation about the last of August or nearly the same time as the previous season but apple harvest was between two and three weeks later. Most of the worms had left the fruit and spun their cocoons before late apple harvest.

For the seasons of 1907 and 1908 Jenne reared three broods. In 1908 the emergence of moths was recorded as early as April 1, and larvæ as early as April 27. Their development during this season, however, was relatively slow.

The time of hatching of larvæ in economic numbers in relation to the falling of the petals varied considerably. In 1918 the interval was three weeks, while in 1919 it was five weeks. Jenne's records for 1907 and 1908 are six weeks and three weeks respectively.

From the standpoint of control there are but two distinct periods of codling moth hatching during which the fruit must be protected not-

withstanding the fact that three or four broods may occur annually. The first period is covered by the first brood and the second period by the second and following broods, which overlap so heavily that they are to all intents one brood. In this respect the problem in the Ozarks resembles that of northern fruit sections since the two dates of particular importance in the seasonal history of the insect are: the time of beginning of hatching of first brood larvæ in economic numbers, and the time of beginning of hatching of the second brood larvæ. The problem differs materially in that instead of one or two second brood applications, three or four applications are necessary for the second and following broods.

All spray applications, with the exception of the calyx spray, are based upon these two dates. As may be expected a spray application is made at the beginning of the first brood and of the second brood. An additional first brood spray is applied at a fixed interval (usually two weeks) following the first application to give continuous protection. Additional applications for the second and following broods are spaced at intervals following the first second brood application to give protection until near harvest. This interval is usually three weeks and is based on the growth of the fruit and amount of precipitation. The time of beginning of hatching of the third and fourth broods is not of consequence in planning a spray schedule as there is no interval between broods when it is safe to leave the fruit unprotected.

It is more difficult to determine the time for making the earliest first brood application than the first second brood application.

As noted above there are anywhere from three to six weeks after the falling of the petals before larvæ of the first brood begin hatching in appreciable numbers. With such a variation it is not possible to recommend for any season in advance that the first spray following the calyx application should be made at a stated time, say three or four weeks later as seems to be practical in many other regions. The time for this application must be determined by life history studies each season. To make the matter more difficult the time of emergence of the earliest moths is not a reliable index for the time of the beginning of hatching of larvæ in economic numbers, as the interval between these events of seasonal history varies to too great an extent. The interval was 18 days in 1918 and 38 days in 1919.

The time between the emergence of the earliest first brood moths and the hatching of the earliest second brood larvæ was 10 days in 1908 and 1918 and 8 days in 1919. Hatching in considerable numbers began soon after. It is reasonable that the timing of the first second brood spray may safely be based on the beginning of emergence of first brood moths.

Remedial Measures

Experimental spraying for the control of the codling moth was carried on for the seasons of 1918 and 1919, the time of applications being based on the life history studies. A few of the plats covering the work for each season are given in Table I, which shows the percentage of fruit free from codling moth for each plat. All plats shown in this table, except the checks, received six sprays with arsenate of lead beginning with the calyx application followed by two others for the first brood and three others for the second and following broods. Plats 1 during both years were the demonstration plats on which spray rods, with nozzles having very fine openings in the discs, were used throughout the season after the calyx application, which gave a complete covering of the fruit until near the close of the season. Plats 14 and 13 were the unsprayed plats for 1918 and 1919 respectively. In 1918 on plat 9 and in 1919 on plat 7 a spray-gun was used from the ground, and in 1919 a spray-gun was used from the tower on plat 6.

Table I Comparison of Sprayed and Unsprayed Plats for 1918 and 1919, Bentonville, Ark.

Plat	Total fruit	Total wormy	Per cent free from worms
1918			
1	5,241	757	85 55
9	4,184	1,950	53 39
14 (Check)	3,380	2,456	27 33
1919			
1	8,934	64	99 28
6	6,573	1,455	77 86
7	11,944	1,513	87 33
13 (Check)	12,568	5,975	52 45

A comparison of the check plats for each season shows that the codling moth infestation was much more serious during 1918. The last spray application during that season was made on August 5 and apparently it was effective until the last week in August by which date very few worms had infested the fruit. The hot weather referred to above which continued until late in the season produced, however, an unprecedented crop of late worms many of which were able to enter the fruit. An additional spray, applied two to three weeks after August 5, doubtless would have protected the fruit against this late infestation of worms. Fully two-thirds of the wormy apples on plat 1 can be attributed to these late worms. The percentage of wormy fruit on all plats that received less than six applications during 1918 was considerably higher than on plat 1.

By following practically the same methods in 1919 the same number of applications produced almost perfect results, 99.28 per cent of the fruit being free from worms in comparison with 85.55 per cent for the

previous season. Cooler weather prevailed throughout 1919, however, so that no part of a fourth brood appeared; all broods were later in the season, and the infestation was correspondingly less as is shown by the check plat. The last spray, put on August 11 to 12, was late enough to protect the fruit against all late worms. On one plat a later application was made but this proved to be unnecessary.

In the case of plat 9 in 1918 where a spray-gun was used from the ground nearly one-half of the fruit was wormy. In 1919 on plats 6 and 7 where the spray-gun was used from the tower and the ground the results were 77.86 and 87.33 per cent respectively. This may be explained by the fact that it is impossible to give the fruit as fine a coat of spray material with the gun and the tendency to overspray some parts of the trees and underspray other parts is greatly increased. The results in these plats were relatively much poorer in 1918 when the infestation was much more severe than in 1919. It is probable that these results may not be applicable in regions where the infestation is less severe and where the requirements of spray being distributed uniformly over the apple is less exacting. However, these plats clearly demonstrate the inefficiency of relatively coarse sprays under Ozark conditions.

The conclusions that may be drawn from the experimental work in the control of the codling moth in the Ozarks thus far are the necessity of making six to seven spray applications, depending upon the season, and the desirability of a very fine mist in preference to a coarse spray.

Mr. E. G. Kelly: What pressure did you use with the gun?

Mr. Dwight Isely: Two hundred and fifty pounds.

President W. C. O'Kane: The next paper is "Some Experiences with the Codling Moth," by T. J. Headlee.

SOME EXPERIENCES WITH THE CODLING MOTH

By Thomas J. Headlee, Ph.D., *New Brunswick, N. J.*

New Jersey Conditions

It no doubt seems to many of the members of our association, particularly the younger ones, that the codling moth is an exceedingly threadbare subject, but the writer's experience in the last two years with this insect has indicated to him that there are still many important facts in connection with its control that are not yet sufficiently understood. In the last two years, he has seen pretty nearly nine out of every ten orchardmen in his state fail to obtain a satisfactory control of this insect. Not only has he observed it in New Jersey, but he finds that a similar condition appears to exist in the state of Delaware.

This is not because these growers have not had the benefit of information gathered about this insect in the country at large, but because spraying methods as outlined by these studies have in most cases proven insufficient to handle the codling moth when it occurs in maximum numbers in that part of the Atlantic Coastal Plain above referred to.

The writer has not been able to find any thorough-going studies of this insect in this region of the country and there is reason to suspect that its habits differ materially from those exhibited in parts of the United States where careful studies have been made. Furthermore the rainfall in this portion of the Atlantic Coastal Plain is large, especially abundant during the first half of the apple growing season and consequently spraying materials stick less well to the foliage and fruit of apple.

It is true that a good many individual orchardists in New Jersey have been able to prevent the codling moth from doing their crops serious harm, but in all cases with which the writer is familiar where these results have been obtained, the coating of spray materials has been maintained year after year from the dropping of the petals through the first half of the growing season.

With these facts in mind an investigation of the codling moth with special reference to the entrance of the fruit by the larvæ was undertaken at the beginning of last summer. Two orchards were selected, one at Maple Shade in Burlington County about 5 miles northeast of the city of Camden and the other at Glassboro in Gloucester County about 20 miles southeast of Camden. Each orchard was located in a large orcharding section. It was anticipated that the difference in location was sufficient to produce a slight difference in the life cycle of the insect, but the study showed distinctly that the seasonal cycle in each place was practically identical. The work at these two places was checked with observations made at New Brunswick. There appears to exist between the life cycle of the codling moth at New Brunswick on the one hand and Maple Shade and Glassboro on the other hand, a difference of about one week. At Maple Shade and Glassboro the adult moths began emerging about May 3, reached their maximum about June 1 and ceased about June 12. The second brood began emerging about July 8, reached maximum about July 29 and ceased September 1. The first brood larvæ began entering the apples about June 1, reached maximum about June 25 and ceased about July 8. The second brood larvæ began entrance about July 25, reached maximum about August 11 and ceased about September 15. The apple bloom in general covered a period of nearly two weeks, the blossoms falling off the trees about May 3. From the falling of the petals until the begin-

ning of entrance by the first brood larvæ there was a period of about four weeks. From the falling of the bloom to the beginning of entrance by the second brood larvæ there was a period of nearly twelve weeks. In cases where the time of spraying was determined by the entrance of the larvæ such a degree of control was obtained that less than one per cent of the picked fruit showed injury by the codling moth. This occurred even in orchards where the previous year had shown in spite of spraying over 50 per cent of the picked fruit damaged by this insect. In one orchard of over 100 acres of pears where the previous year not less than 60 per cent of the fruit was damaged by the codling moth, this year less than one per cent of the picked fruit showed injury. This year it made the owner a good profit. About 40,000 baskets of pears were harvested and sold, none of which brought less than ninety cents a basket.

Control Problems

There seem to be two main problems in meeting the codling moth as the writer has seen it in New Jersey. The first is concerned with the comparative value of the three sprays that are usually recommended for its control. The second is concerned with finding the relation between the time when the spray should be applied and the development of the trees.

Nearly but not quite all of the most careful work hitherto done, so far as the writer has had a chance to examine it, seems to indicate the preëminent importance of the blossom fall spray. Large amounts of data covering periods of several years have been gathered by Quaintance[1] and his associates, Ball,[2] Melander[3] and Felt.[4] These collections of data all seem to indicate unmistakably that the first or blossom fall spray is many times more important than any other spray for control of the codling moth. Sanderson[5] presented a keen analysis of the results obtained up to that time and showed that up to 1909 the data gave the place of first importance to the blossom fall spray but that the later sprays were also of large importance. Furthermore, most of the workers, who maintain the preëminent importance of the blossom fall spray recommend later sprays as well. The writer has seen orchards in each of the last two years where the amount of blossom end worminess would not amount to one-tenth of one per cent and he has seen some instances in which it was almost impossible to find any whatever,

[1] Quaintance *et al.*, Bu. of Ent., U. S. Dept. of Agric., Buls. 80, Pt. VII, 1909, 1915, Pt. II, 1912 and 88, 1914.

[2] Ball, E. D., Utah Station, Bul. 95, 1904 and 129, 1911.

[3] Melander, A. L., Wash. Sta. Bul. 103, 1911, and others issued personally.

[4] Felt, E. P., Jour. of Econ. Ent., Vol. 5, page 153, 1912.

[5] Sanderson, E. D., Jour. of Econ. Ent., Vol. II, pages 141–153, 1909.

although the same orchards at the end of the season showed from 50 to 85 per cent of the picked fruit wormy. During the past season he observed rather closely some apple trees near his home which received no growing season spray whatever. The blossom end worminess in these trees was an almost negligible factor, but at the end of the season not much less than 100 per cent of the picked fruit was ruined by the codling moth. There is no intention to regard these observations as being in any way sufficient to controvert the great mass of evidence in the other direction, but it is thought they indicate that codling moth habits as determined in the country at large may not apply completely to codling moth habits in the Atlantic Coastal Plain. There is no doubt whatever in the writer's mind that a single spray applied by orchardmen at the blossom fall under codling moth conditions, such as obtained in New Jersey, during the past two years will utterly fail to give satisfactory control. He believes this to be true even where the spray is applied with the utmost care and thoroughness.

It thus appears that the observations recorded above indicate first, that blossom fall spray does not possess in all cases the preëminent value it has been shown to have where studies hitherto have been made and, second, that the sprays given at the entrance of the first brood larvæ and at the entrance of the second brood larvæ are also of prime importance in effecting satisfactory control.

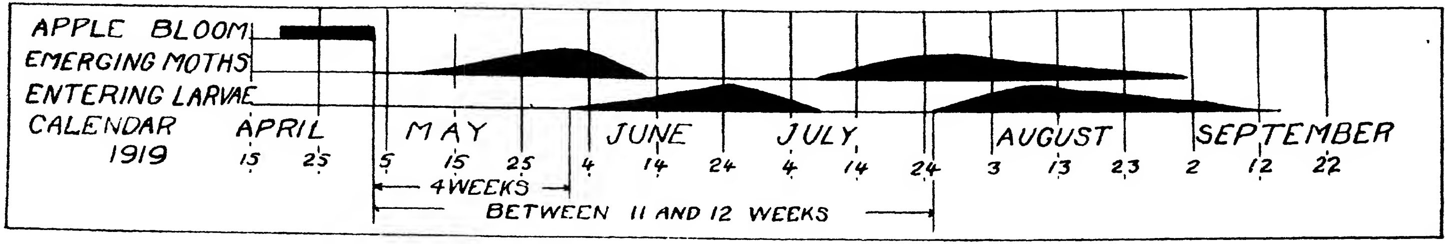
Examination of spraying schedules published by different station and government agencies in this country indicate that there exists a difference of opinion as to the method which should be chosen to outline the proper time of spraying. Some schedules designate the sprays as coming so many days and weeks after the blossom fall, others indicate the proper time of spraying by means of a day and monthly date and still others use a combination of the two methods. The labors of Melander,[1] Jenne,[2] Hammer[3] and Siegler-Simanton[4] indicate that the period separating the falling of the blossoms and the emergence of the adult moths is a rather highly variable thing. The work of Hammer also indicates that the time of the activity of the second brood varies but little from year to year. This condition would appear to indicate for sprays intended to protect the fruit from the side worms of the first brood larvæ, there is no very definite method of determining the proper time and that a day and month date indication should be sufficient for the spray intended to protect the fruit from the side worm of the second

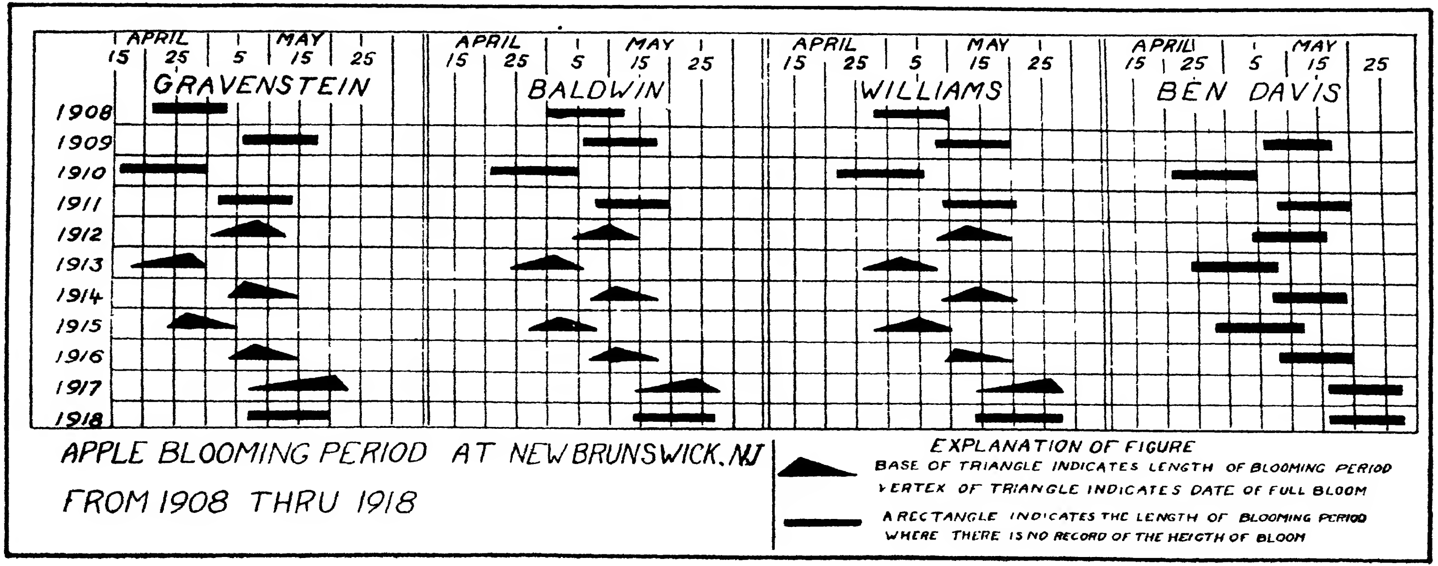
[1] Melander, A. L., Wash. Sta. Bul. 77, 1906.

[2] Jenne, E. L., Bureau of Ent., Bul. 80, Pt. I, 1909, interval 6 and 3 weeks.

[3] Hammer, A. G., Bureau of Ent., U. S. Dept. of Agric, Bul. 115, Pt. I, 1912.

[4] Siegler, E. H., Simanton, F. L., Bureau of Ent., U. S. Dept. of Agric., Bul. No. 252.





APPLE BLOOMING PERIOD AT NEW BRUNSWICK, NJ FROM 1908 THRU 1918

brood. All studies agree in placing the time for the first spraying for codling moth at the falling of the blossoms. Taking the great mass of codling moth study in general and accepting the work of the men mentioned, the writer believes that the consensus of opinion would place the spraying which is intended to protect the fruit from the side-worms of the first brood about three weeks after the blossoms fall and would place the spray which is intended to protect the fruit from the side worms of the second brood about nine weeks after the blossoms fall.

A study made of the blooming period for Gravenstein, Baldwin, Williams and Ben Davis, extending from the year 1908 to the year 1918 shows an extreme variation of about three weeks and an average variation of a trifle over a week. It is the writer's understanding, drawn from different sources, that this variation is due primarily to temperature. Knowing the tremendous retarding effect of low temperatures and the large accelerating effect of higher temperatures, the writer is inclined to believe that the temperature factor would operate upon the codling moth in much the same way and to about the same extent as it does on the tree. He is, therefore, inclined to think that the interval existing between the blossom fall and the larval entrance into the fruit is not so variable as has hitherto been shown. Without doubt factors of moisture seem to influence the codling moth pupa somewhat differently from the way in which they influence the blooming period of the tree and variations due to that cause may very well take place, but the amount of variations resultant is not likely to be large enough materially to change the relationship between the time of bloom and the time of larval entrance.

The facts above set forth seem to leave the question of the method of indicating the time of the spray for control of the first brood of side worms unsettled. It may be said that Quaintance has obtained excellent results from the day and month date method and that equally good results have been obtained by following a schedule based on the blossom period. The underlying factors do not seem to have been worked out and further investigations will, in the writer's opinion, bring them forth.

Explanation of Charts 1 and 2

Chart 1 showing the emergence of broods of moths and the period covered by the entrance of their larvæ into the apples in 1919, at Maple Shade near Camden, N. J.

Chart 2 showing the blooming period of four varieties of apples from 1908 to 1918 inclusive. Extreme variation is about three weeks and average about one and one half weeks.

The writer wishes to invite attention to the fact that in his judgment enough study has been given to various insects, especially apple aphis to indicate that insect habits on the coastal plain are somewhat different from the habits of the same species in other parts of the United States. The past year's preliminary study of the codling moth in this area seems to bear out this general conclusion. This is not at all surprising because of climatic differences, especially as regards humidity and temperature. If this is so, it follows that any country-wide study of an injurious species should include the Atlantic Coastal Plain as one of the regional areas, the conditions of which must be determined.

Examination of the results of work on codling moth has served to deepen a conviction that has been growing upon the writer for some years:—that in the past and at present the study of insects economically important over several regional areas has been carried out with altogether too little coöperation between state and between state and government agencies. This has resulted in sets of data which are very largely not comparable. If the other method had been taken it is reasonable to anticipate that the essential points in the codling moth control problem would now have been in hand.

Conclusions

In conclusion it should be said that:

First, as shown by a single year's investigation there are only two broods of codling moth in New Jersey;

Second, the blossom fall spray does not appear in this study to have the preëminent importance which it has been shown to have in previous studies elsewhere in the country;

Third, the sprays which come at the time the larvæ of the first and second broods are entering the apples are not only of much greater importance than has hitherto been attributed to them, but are absolutely necessary to satisfactory control when the codling moth is present in as great abundance as is now the case in New Jersey and probably Delaware;

Fourth, that portion of the Atlantic Coastal Plain comprised in the southern half of New Jersey and probably Delaware varies sufficiently so to modify the habits of economic species of insects coming within its range as to render the studies made of them elsewhere in the country only partially applicable to coastal plain conditions;

Fifth, studies of country-wide economic species should be carried out on a regional basis under a plan which comprehends extensive and thorough-going coöperation between state and between state and government agencies.

Mr. James Troop: I would like to ask if he found any well marked period existing between the end of the first brood and the beginning of the second brood of the codling moth. There are two broods. Does the first brood come to maturity in your locality before the second brood makes its appearance?

Mr. T. J. Headlee: That is a question that I didn't work out. The chart that was passed around shows that the period of the first brood has entirely gone before the period of the second begins.

Mr. James Troop: I would like to say right here that in Indiana we have been doing some work with the codling moth for several years. Our apple growers have not been getting results by following the programs as laid down for spraying. For the last two or three years, we have been studying the life history of codling moth in our section of the country. We begin with the emergence of the first moths in May. Our work consists of banding the trees, gathering the larvæ, putting them into cages, keeping these cages, as nearly as possible, under natural conditions, and making daily records of the emergence of the moths.

We have found that from the middle of May until the first of September, when our experiments stopped, we couldn't find a time when moths were not emerging. Practically every day from the time the first moths appear, with the exception of just here and there a day, until they close up business in September, there is a continuous performance right through the whole season with no break at all between the first and second broods. They are at work all the time, so we have concluded that the only way to protect our apples is to keep the spraying machine going continuously from early summer till the first of September.

President W. C. O'Kane: The title of the next paper is "The Oyster-Shell Scale in Illinois," by P. A. Glenn.

FORMS OF THE OYSTER-SHELL SCALE IN ILLINOIS

By P. A. Glenn, *Chief Inspector, Division of Plant Industry, Department of Agriculture, Urbana, Ill.*

Doubts have been entertained by entomologists as to whether the oyster-shell scale which infests various species of deciduous trees belongs to the single European species, *Lepidosaphes ulmi*.

These doubts have been greatly strengthened in the mind of the writer by observations made during the last six years.

In Urbana and Champaign, Ill., the poplar, ash, lilac, cornus, willow and *Rosa rugosa*, are quite generally, and in most cases badly, infested by the oyster-shell scale.

In the spring of 1914 an attempt to transfer this scale from poplar,

ash and lilac to apple failed, evidently for the reason that it could not live on apple. Observations made throughout the Twin Cities disclosed the fact that apple trees though standing in such close proximity to heavily infested ash, poplar and lilac that their branches touched were free from scale; and, furthermore, pear, peach, plum, hackberry and horse-chestnut, all of which are listed as host plants of *Lepidosaphes ulmi*, standing in the same situations were likewise free. A closer examination of specimens taken from apple, poplar, ash, willow, lilac, cornus and *Rosa rugosa* brought to light two distinct forms of the scale, and a third form which differs in some particulars from that which infests apple. For the purpose of this paper we shall designate them as the brown form, the grayish-brown, or banded form, and the yellowish-brown form.

The brown form is the one which infests apple. It appears to be identical with the European species, *Lepidosaphes ulmi* Linnaeus. It has been successfully transferred to lilac, ash and cornus. An attempt to transfer it to poplar was unsuccessful, but the failure may have been due to the small number of young insects used in the experiment. The shade of color of the scale itself varies somewhat on different kinds of bark, but it is a uniform brown. In immature specimens the part of the scale developed after the first molt is darker than the exuvia. Specimens of old scale which have been exposed to the weather are very dark, nearly black. This scale is double-brooded, the first brood hatching during the first or second week in May at Urbana, the second brood during the latter part of July. This form is usually very heavily parasitized.

The grayish-brown scale is the one that is generally and destructively abundant on poplar, ash, willow, lilac, cornus, and *Rosa rugosa* in Urbana and Champaign, and at numerous other places in the northern half of the state. American elm, soft and hard maple, ailanthus and linden growing near heavily infested ash and poplar may become infested and be seriously injured by the large number of young which are carried to them annually from the infested trees, but in other situations they do not become infested, and it is doubtful whether the scale can maintain itself on them. It cannot live on apple, pear, peach, plum, hackberry and horse-chestnut.

The prevailing color of this scale is brown, but there are more or less distinct transverse grayish bands, one just behind the first exuvia, another near the middle of the scale, and a third at the posterior margin. These bands are sufficiently distinct and constant to serve as a means of distinguishing this form from the other two.

Old scales when exposed to the weather become a bluish-white. In immature specimens the part of the scale formed, after the first molt,

is nearly gray and lighter in color than the exuvia. It is single-brooded and hatches at Urbana, Ill., during the third or fourth week in May.

The yellowish-brown form has been taken on cornus, lilac, soft maple and *Rosa rugosa* at Urbana. This form resembles the brown form very closely, but the posterior half of the scale is lighter in color than the anterior part and is in most cases distinctly yellowish. This characteristic cannot always be depended upon to distinguish it from the brown form, but in connection with one of the microscopic characteristics of the two forms they can be quite readily distinguished. It is double-brooded, and is usually heavily parasitized.

Many specimens of each of these forms have been examined under the microscope and with the exception of the number of circumgenital pores they seem to be identical. Specimens were submitted to Dr. A. D. MacGillivray. He made a careful comparison of the structural characteristics which up to the present time have been used to determine the species in this genus and reported that he could find no difference.

It is interesting to note, however, that there is a striking and quite constant difference in the average number of circumgenital pores in these forms, as the following table will show:

CIRCUMGENITAL PORES

Form of scale	Number examined	Host plant	Posterior lateral groups			Anterior lateral groups			Median group			Total Average
			Max	Min	Aver	Max	Min	Aver	Max	Min	Aver	
Brown	30	Apple	21	8	12 8	21	9	16 8	12	8	9 5	68 7
	30	"	17	8	13 9	23	12	19	14	9	12	77 8
	30	"	17	8	13 5	23	13	17 7	17	7	11 5	73 9
	30	"	19	8	13 8	23	13	16 8	16	6	10 5	71 7
Average	120				13 5			17 0			10 9	73 1
Yellowish-brown	36	Cornus	25	13	17 2	24	14	19	17	8	12	84 4
	23	"	21	12	16 1	23	11	18 6	16	9	12	81 4
	23	Per Lilac	22	15	16 45	23	10	19 1	21	8	13	84 2
	24	Rosa Rugosa	24	13	16 7	24	13	18 8	18	10	13 8	85 6
Average	106				16 5			18 8			12 6	83 2
Grayish-brown or banded	27	Lilac	27	16	21	30	15	23 2	21	11	14 4	102 8
	20	"	28	17	21 2	26	13	21 6	14	9	12 3	97 9
	32	"	27	15	19	28	15	21 5	22	8	13 2	94 2
	30	Poplar	32	14	21	29	17	22 7	16	10	13 9	101 3
	32	Ash	29	17	22 6	29	18	24 7	19	12	14 3	108 9
	27	Pus. Willow	27	17	21 5	28	18	23 3	11	11	14 3	103 9
	11	" "	30	22	24 3	30	17	24 5	17	10	15 1	112 7
	27	Rosa Rugosa	31	16	23 5	30	17	23 7	20	10	15.	109 4
	26	Weep. Wil.	29	16	23 2	30	21	25.	18	9	14.4	110 4
Average	232				21.9			23 2			13.9	104 1

There is a considerable variation in the number of circumgenital pores in individuals of the same group, so much so that it would be

possible to find some individuals in each of the groups which could not be properly classified by means of the circumgenital pores alone. There is also a considerable variation in the averages of lots belonging to the same form, but these variations are not so great as to render it even doubtful as to which form each of the lots belongs.

The differences which have been noted in these forms are summarized below:

Brown or apple form	Yellowish-brown form	Grayish-brown or banded form
Uniform in color	Posterior half of scale lighter in color with yellowish hue	Brown crossed with three grayish bands
Weathered scales very dark	Weathered scales very dark	Weathered scales bluish-white
Double-brooded	Double-brooded	Single-brooded
Parasitized	Parasitized	Not parasitized
Infests apple	Probably does not infest apple	Does not infest apple
Probably does not infest poplar	Infests poplar	Infests poplar
Infests pear, peach, plum, hackberry and horse-chestnut		Does not infest pear, peach, plum, hackberry and horse-chestnut
Average number of circumgenital pores, 73.1	Average number of circumgenital pores, 83.3	Average number of circumgenital pores, 104.1

We are not in a position to offer any definite suggestion as to the systematic relation of the different forms, but the one that infests the apple is no doubt identical with the European form, *Lepidosaphes ulmi*. The yellowish-brown form should probably be considered as a variety of *Lepidosaphes ulmi* Linneus. The grayish-brown or banded form may possibly be only a variety of *Lepidosaphes ulmi*, but it seems more probable that specific characteristics will yet be found which will make it possible to describe it as a separate species, or possibly to identify it as one of the other European species already described. The fact that it infests mainly artificial plantings, indicates that it has come to us in the nursery trade and probably from Europe.

At present the economic importance of the banded form is of greater concern than its systematic relations. As a fruit pest it is of no consequence, but in cities it is now much more abundant in Illinois than either of the other forms, and from the published records of the oyster-

shell scale, we may infer that this is also true in other states. It is much more destructive than the other forms and observations made during the last six years lead us to believe that it will eliminate the poplar and the ash and possibly all of its favorite host plants from parks and lawns, unless systematic control measures are adopted, or some parasite or other nautral enemy appears to keep it under control. The only evidence of such an enemy which has come to our attention was the receipt some time ago from the northern part of Illinois of some lilac which had been heavily infested by the scale, 95 per cent of which had been destroyed evidently by a bird or some predacious enemy.

This insect can be controlled by spraying with the lime sulphur wash, but the spraying of large shade trees is expensive and requires apparatus built especially for this kind of work. Spraying large street trees and trees in lawns is in many cases impracticable, because it is impossible to spray them with the lime sulphur wash without ruining the paint on nearby buildings and this wash is by far the most effective dormant spray for this insect. Miscible oils have not proven satisfactory. The only practicable method of procedure is to cut down infested trees which cannot be sprayed and replace them with others not susceptible to this pest. Poplars are especially objectionable because the scale multiplies so rapidly on them. Because of their tall growing habit they are exceedingly difficult to spray, and because of their hardiness they resist the attack of the scale and serve as disseminating centers for it for many years. For these as well as for other good reasons the poplar should be eliminated from city plantings, and other trees, not susceptible to the scale substituted. A very careful inspection should be made of nurseries and all infested stock destroyed at once. Since the control of this pest is for the most part a city problem, the attention of city authorities should be called to it, and drastic measures recommended, if necessary.

Mr. Childs: I might say that in Hood River, Oregon, there occurs conditions relative to the habits of the oyster shell scale of much the same nature as Mr. Glenn speaks. We often find dogwood being killed by the scale in ravines running through orchards and no scales will be found on the apple trees adjoining. I have also noted this difference in the texture of the scale on different host plants.

Mr. J. S. Houser: I was interested in what Mr. Glenn said as to the probable injury to ash by this scale. Several years ago, about fifteen, we had a very severe attack of this scale on ash in Northern Ohio. The attack was virulent for a number of years, and then it disappeared almost entirely. It required a period of something like

ten years to again become very destructive. This last destructive outbreak reached its maximum, I think, about four or five years ago, whereupon the scale again almost entirely disappeared for a year or two, but at the present time is again increasing in numbers. *Hymenopterous* parasites seem to be responsible for this irregularity in the fortunes of the insect.

At this point, the meeting of the Association adjourned and the Section on Horticultural Inspection convened.

Section on Horticultural Inspection

E C. Cotton, *Chairman* J. G. Sanders, *Secretary*

The Section on Horticultural Inspection met in the Soldan High School, St. Louis, Mo., January 1, 1920, at 1:30 p. m., for a single afternoon session.

In order to conserve time, the chairman, E. C. Cotton, dispensed with his address, and after preliminary remarks called for the first paper:

1. "Treating Nursery Stock for the Control of San Jose Scale," which was read by Mr. K. C. Sullivan, and briefly commented on by some of the members.

2. "The Present Status of *Aleurocanthus woglumi* Ashby in the Panama Canal Zone" was not given by Mr. H. F. Dietz, owing to his earlier withdrawal from the U. S. Bureau of Entomology, but Mr. C. L. Marlatt stated that this paper would, in all probability, be published as a bulletin of the Federal Department.

3. The paper on "Important Foreign Insect Pests Collected on Imported Nursery Stock in 1919" was read by Mr. E. R. Sasscer, and discussed by the members present.

Mr. E. E. Scholl stated that the horticultural associations of Texas strongly urged that federal port of entry inspection be established at Galveston. Report was made that federal funds for this purpose had been asked for by the Federal Horticultural Board.

4. The paper on "The Japanese Beetle Problem" was read by Mr. J. J. Davis, and a number of very interesting and instructive slides were shown. Discussion followed.

5. The paper on "The Japanese Beetle Quarantine Work" by C. H. Hadley was omitted, on account of his absence from the meeting.

6. The interesting and very instructive report by Mr. C. L. Marlatt, chairman of the Federal Horticultural Board, on "Federal Plant Quarantine Work and Coöperation with State Officials" was listened to with the greatest interest by everyone present, on account of the

importance of the coöperative possibilities of the Federal Board with state officials in the control of dangerous insects and plant diseases.

BRIEF RÉSUMÉ OF MR. MARLATT'S REPORT

It was made clear that every pronouncement and quarantine issued from the Federal Horticultural Board, is the result of careful study and consideration by leading officials of the Agricultural Department, and, finally, by the sanction of the Honorable Secretary of Agriculture. The results of investigations and the knowledge of the authorities of the entire world are brought to bear on the work of the Federal Board; state officials are taken into consultation, and full consideration is given to every proposition which comes before the board for decision.

The work of the Federal Board has grown to enormous proportions—hardly believed possible in so short a period, since the establishment of the board. The introduction of many new serious pests from foreign countries, attacking our staple crops, has demanded rapid, generous action to cope with the situation.

One of the largest problems confronting the board has been the cotton pest control in the south, particularly along the entire Mexican border, brought about by the introduction and establishment of the pink boll worm. The Federal Board at this time controls all the traffic along the entire Mexican border, and has erected the largest plants for fumigation in the world, which will accommodate fifteen standard freight cars at one time. The attempts at eradication of the pink boll worm have demanded the utmost efforts, and the keenest ingenuity and management on the part of the board officials.

The board inspection service has grown rapidly, and is now established at such important points as Boston, New York, New Orleans, San Francisco and Seattle, with other ports under immediate consideration. It would seem that ultimately the Federal Board port inspection service will be as far-reaching as the customs service, and will work jointly with the latter service.

The intensity of the work looking toward the control of several of our pests, is scarcely realized by the people generally, nor do they realize the efforts which are being made to protect the agricultural and horticultural interests of the United States at this time.

The potato wart, which has very serious potentialities, and which was introduced from Europe into several points in Pennsylvania, and has been discovered in northern West Virginia, is under strict quarantine, and hope is held that the disease may be prevented from further general spread. The determination that several of our American varieties are immune, and also the possibility that some of the immune varieties from the British Isles, which are under test, will prove satis-

factory in our climate, are indeed hopeful signs that this disease may be deprived of its dangerous possibilities.

The discovery of the European corn borer, and the subsequent enlargement of the infested area, by careful surveys, has presented another problem of importance before the board, which it is handling with all the judgment possible—in view of the slight knowledge which we have of the habits and destructive possibilities of this pest in America.

The Federal Board has made the first practical use of the aeroplane in agriculture—in scouting for the illegal growing of cotton along the Mexican border, where attempts to eradicate the pink boll worm are under way.

Quarantine No. 37.—The enactment of this quarantine has brought forth a storm of opposition from plant importers, and, unfortunately, from nurserymen and florists, who have followed the lead, and harkened to the frequent misrepresentations, and often wilfully erroneous statements of the plant importers. As time goes on, these nurserymen, who are growers and producers, are beginning to realize that this quarantine is for their good, and will protect their interests, as well as the agricultural and horticultural interests of the country generally, from the further importation, to a very considerable degree at least, of destructive plant pests.

It is the duty, as Mr. Marlatt said, of every state official and worker to support the Federal Board and the plant quarantine, and to overcome the unfortunate propaganda which has been spread broadcast by the plant importers and misled florists.

Finally, Mr. Marlatt impressed everyone with the importance of a full coöperation of State Quarantine Officials with the Federal Board, and assured the state officials present, that the board would coöperate with the several states in their problems in every way which seemed desirable and feasible, and, furthermore, he offered the services of the board in consideration of any plant quarantine matters which might arise.

Mr. J. G. Sanders offered a resolution, which was passed unanimously, "expressing the gratitude of the Association to Mr. C. L. Marlatt for his long and tireless efforts in securing authority from Congress to establish and to enforce plant quarantines—for the protection of agriculture and horticulture in the United States."

Mr. Paul C. Lindley, officially representing the Southern Nurserymen's Association, presented a report of action taken by the latter association, covering several matters of importance, including uniform horticultural legislation, uniform acceptance of nursery license tags,

and several other matters which are brought out in Mr. Lindley's report, which will be published. Considerable discussion was aroused by Mr. Lindley's report, and remarks were made by several, especially by F. M. O'Byrne of Florida, favoring the use of separate state numbered license tags, thus enabling state officials to keep accurate record of the nursery stock shipped into the state. Other officials felt that such detail could not be followed out, particularly in the northern and eastern states, where enormous quantities of nursery stock are shipped to very many points in the state, thus requiring the reciprocative action in other states by respecting their license tags.

The inspectors present were highly pleased to receive Mr. Lindley's report of the Southern Nurserymen's Association, and assured a kindly hearing to all representatives of the nurserymen, believing that by such exchange of ideas the best possible results can be secured in inspection work.

J. G. Sanders, Harrisburg, Pa., was elected chairman, and Mr. E. R. Sasscer, Washington, D. C., secretary for 1920, following their nominations by the nominating committee, which was composed of Wilmon Newell, Franklin Sherman and W. E. Rumsey.

IMPORTANT FOREIGN INSECT PESTS COLLECTED ON IMPORTED NURZERY STOCK IN 1919

By E. R. Sasscer, *Washington, D. C.*

Notwithstanding the fact that Belgium exported plants to the United States in the fiscal year 1919, the amount of stock entered during this period by the principal countries engaged in this type of trade, was less than in any year since 1912. The number of plants exported by each of the five principal European countries during the fiscal year 1919 is as follows:

England	1,385,548
Holland	2,403,430
France	12,948,466
Belgium	98,836
Germany	None

In fact, there was a falling off on the part of each of the countries, listed above, for the period referred to, except Belgium. This country's increase is due to the fact that no plants were exported to the United States during the fiscal year 1918. Germany, of course, has not exported plants to the United States since 1916.

An examination of the records of interceptions for the current year shows that insects arriving on imported stock have not decreased but have been equally as abundant, if not more so, than was the case in

former years. While it is true that many of these interceptions were made on plants from countries without inspection facilities, a large percentage of the interceptions were made on stock from countries which possess a recognized inspection service. As the result of some ten or more years of experience in inspection work, the writer is convinced that it is impossible for any man, or group of men, to examine a large shipment of plants and locate every insect which may be present. We have been repeatedly advised that the stock exported by the five principal countries to the United States was carefully examined by recognized experts, and yet there was seldom, if ever, a shipment of any size which did not show insects of some description when examined in this country by State or Federal Inspectors. Morever, a reinspection of these same shipments would undoubtedly reveal insects which escaped attention at the time the two previous examinations were made. It is absolutely impossible to detect insects in soil around balled plants, without removing, and, in many instances, sifting the soil, which treatment to some plants would be fatal. Fortunately, this difficulty has been eliminated by the exclusion of soil around plants. Scale insects and Aleurodids are difficult to locate even by experts on these families of insects. On a number of occasions in recent years, we have reinspected, in Washington, three or four times a half dozen of small plants infested with the mining scale (*Howardia biclavis* Comst.), and each reëxamination invariably revealed scales which were under buds or in some secluded spót, and had escaped the eyes of the inspectors on previous inspections. It is true that this scale is a difficult one to detect, but the examinations were made under favorable conditions in a well-lighted room.

Unfamiliarity with the work and injury occasioned by the oriental fruit moth (*Laspeyresia molesta* Busck) undoubtedly caused inspectors of this country to pass supposedly free but infested stock which bore a foreign certificate of inspection.

These facts are not given to minimize the work of foreign inspectors, but to emphasize that where the human element enters it is impossible to say definitely that a nursery or given shipment is free from injurious insects. Someone may say that it is possible to definitely assume that a nursery or a case of plants is free from injurious insects, but how are we to determine whether or not an insect of no economic importance in Holland will not in this country become injurious and indeed change its habits and preferred hosts.

A number of the insects referred to below, have been intercepted in former years, and if the wholesale exportation of miscellaneous plants had not been stopped these insects and many others would, no doubt, have continued to enter with foreign plants and plant products.

The pink bollworm (*Pectinophora gossypiella* Saunders) was collected in cotton seed from China, Angola, Africa, and Mexico. Inasmuch as this insect has received so much attention in literature of late, there is no need of elaborating on the injury occasioned to cotton by this pest at this time.

Yams from Jamaica were found to be infested with *Palaeopus dioscoreæ* Pierce, a weevil which, thus far, seems to be confined to that island. Sweet potatoes, arriving in New York from Antigua, British West Indies, were found to harbor living larvæ, purpæ, and adults of the scarabee (*Euscepes batatæ* Waterhouse), and sweet potato cuttings from Hawaii were infested with *Euscepes porcellus* Boheman. Apparently none of these weevils are now established in the United States.

Larvæ of presumably *Anastrepha fraterculus* Wied. were intercepted in New Orleans in grapefruit and mangos from Cuba, Guatemala, and Jamaica. The gold-tail moth (*Porthesia similis* Fuessl.) was taken on *Acer atropurpurea* and *Azalea amoena* from Holland, and the sorrel cutworm (*Acronycta rumicis* L.) was intercepted on two shipments of pear and quince from France. Nests of the brown-tail moth (*Euproctis chrysorrhœa* L.) were found in five French shipments of Cotoneaster, apple and Manetti stock, and egg masses of the gipsy moth (*Porthetria dispar* L.) were present on quince, apple, and Manetti stocks from France and on boxwood from Holland. Rhododendrons and boxwood from Holland exhibited *Agonopteryx ocellana* Fabr., and azaleas from the same country were infested with *Gracilaria zachrysa* Meyr., as were also two shipments of the same plants from Belgium.

An undescribed species of Recticulitermes was taken in moss used as packing around the roots of Litchi and citrus from the Philippine Islands, and a species of Melanotus was taken in ship's ballast from Spain. Soil around Dutch rhododendrons was found to harbor *Athous niger* L., and rice straw used as packing in Japan was infested with a species of Crambus.

Pineapple shoots from the Straits Settlements were thickly infested with a small mite (*Stigmarodes cinctus* Ewing) which seems to be established in the United States and confined to the southwest.

Japanese wistarias arrived infested with *Agromyza shineri* Girard, and a species of Xyleborus, and tamarind seed pods from Guatemala and Cape Verde Islands were infested with *Calandra linearis* Herbst. Soil around azaleas from Holland was found to carry the European mole cricket (*Gryllotalpa gryllotalpa* L.) which probably confirms the belief which has prevailed for some time that the introduction into New Jersey several years ago was attributable to soil around balled plants. Two shipments of Japanese figs were found infested with a cerambycid

(*Melanauster chinensis* Forester), and *Emphytus cinctus* L. was received on miscellaneous plants from England, Scotland, France, and Holland.

In order to get some idea in regard to the possibility of injurious insects entering in bulbs, a number of shipments were given a rather careful inspection. One Holland shipment of lily-of-the-valley was found to contain *Otiorhynchus sulcatus* Fabr., and a Pyralid (*Pyralis farinalis* L.) was collected in three shipments from France; one of hyacinths and two of narcissus. The lesser bulb fly (*Eumerus strigatus* Fallen) was taken in several shipments of Dutch and French narcissus and jonquils, as was also the narcissus fly (*Merodon equestris* Fabr.). A large percentage of the shipments were found to contain bulbs infested with *Rhyzoglyphus rhizophagus* Banks and *Rhyzoglyphus hyacinthi* Boisd.

Fully 85 per cent of the bulbs of a large shipment of French *Iris tingitana* were infested with *Anuraphis tulipæ* Boyer, and a species of the same genus was also received on *Iris alberti* from England. A new species of Liothrips was found on lily from France, and what appears to be an undescribed species of Tarsonemus was taken on narcissus from Holland. Unidentified Chironomids, Cecidomyids, and Agromyzids were also intercepted.

As in former years Coccids were frequently met with, the more important being the following:

Aspidiotus transparens Green on Cycads from Port Elizabeth, South Africa.
Selenaspidus pumilis Brain on ———, from Kimberley, South Africa.
Targionia bromeliæ (Newst.) on pineapple shoots from Straits Settlements.
Targionia hartii Ckll. on yams and sweet potatoes from Africa.
Targionia sacchari Ckll. on sugar cane from Porto Rico.
Chionaspis exalbida Ckll. on aloe and Pandanus from Port Elizabeth, South Africa.
Chionaspis niger Ckll. on Litchi from Hawaii.
Lepidosaphes alba (Ckll.) on *Manihot sp.* from St. Kitts, British West Indies, Bahama Islands, and the Belgian Congo, and on *Manihot esculenta* from Jamaica.
Parlatoria calianthina B. & L. on *Pyrus communis* from Algeria.
Parlatoria pseudaspidiotus Lindg. on orchids from the Philippine Islands.
Lecanium cerasorum (Ckll.) on wistaria from Japan.
Lecanium kunoensis (Kuwana) on plums from Japan.
Lecanium persicæ (Fab.) European Peach Scale, on *Berberis verraculosa* from France.
Pulvinaria floccifera (Westw.) on *Renanthera imschootiana* from England.
Pseudococcus boninensis Kuwana on sugar cane from Argentine.
Pseudococcus comstocki Kuw. on persimmon from Japan.
Pseudococcus crotonis (Green) on orchid from Porto Rico.
Pseudococcus sacchari (Ckll.) on cow cane from Rhodesia, also Indian cane from Rhodesia, and on sugar cane from Cuba and the Virgin Islands.
Pseudococcus virgatus (Ckll.) on Litchi from the Philippine Islands.

THE GREEN JAPANESE BEETLE PROBLEM

By John J. Davis, *Riverton, N. J.*

It is intended at this time to give a concise résumé of the green Japanese beetle problem, including its present status, plans for future work and information which is of special interest to you whose duty it is to protect your state from the introduction of dangerous insect pests.

The green Japanese beetle (*Popillia japonica* Newm.), a native of Japan, was introduced into the United States at Burlington County, New Jersey, prior to 1916, probably five or six years ago, and presumably in the grub stage in soil about the roots of perennial plants. It was first discovered by Messrs. Harry B. Weiss and Edgar L. Dickerson about the middle of August, 1916, in a nursery, probably near the original point of introduction,[1] near Riverton, New Jersey.

The rate of increase has been remarkable. When discovered in 1916 only about a dozen beetles were found, according to Mr. Weiss, and these only after a search, while now (1919) in the same locality and at the same season one person can collect by hand 15,000 to 20,000 beetles in a day and in favorite places the grubs are as frequent as 250 to the square yard. The area of known infestation has increased from approximately 600 acres in 1917 to 15,000 acres in 1919 and according to the most conservative estimates by those familiar with the activities of the insect a year ago, the beetles were at least ten times more abundant numerically in 1919 than the previous year.

The Bureau of Entomology inaugurated a study of this insect in the late summer of 1917, Mr. Wm. O. Ellis being assigned to the study of its life history and habits. Mr. Ellis continued his connection with the project until the summer of 1919 and most of the data on the life history are the result of his investigations. In the spring of 1918 it was planned to take active steps to control and, if possible, eradicate the insect, the New Jersey State Department of Agriculture coöperating substantially. Mr. W. H. Goodwin was assigned the task of control, he and Mr. Ellis working jointly on the problem in their respective fields, the whole project being supported by an advisory board, consisting of Doctors A. L. Quaintance and Thos. J. Headlee. Mr. Goodwin continued his service in charge of control operations until the fall of 1919. The writer was assigned to this project May 1, 1919, and has had in charge of the different divisions Messrs. Goodwin for control operations, Ellis, the life history, and C. H. Hadley, the quar-

[1] It is a matter of historical interest that this insect was first found within about one-quarter mile of the place where the San José scale was first discovered in the eastern United States.

antine. At the present time Mr. Hadley has charge of the control operations and Mr. D. N. Willingmyre the clean-up work. Entomologists have not yet been assigned for the divisions of quarantine, experimental investigations or parasite introduction work for the coming season.[1]

To finance an attempt to eradicate the beetle from New Jersey, $15,000 were provided, $10,000 by the federal and $5,000 by the state governments. The project thus provided for began in 1918. It was thought at the end of 1918 that the probability of extermination was slight and that greater emphasis should be placed on control. On the basis of the accumulated knowledge and experience, it was planned to ask for an appropriation of $35,000 ($25,000 from the federal and $10,000[2] from the state governments).

This amount was granted. After a season's work and a study of the situation the past year (1919) it was decided that the policy of eradication must be abandoned for reasons which will be given later, but that a vigorous policy of control should be inaugurated. Careful estimates called for an additional minimum expenditure of $70,000 to prevent the further spread of the insect and at the same time discover practical control measures and attempt introductions of the natural enemies from Japan. Congress appropriated $45,000 of this amount and while it will enable us to do a considerable amount of needed and valuable work, it is quite insufficient to complete the plans deemed necessary for success. Regardless of the fact that the work the past two seasons has been carried out in accordance with the best knowledge of the insect's life habits, which were at that time available, the insect has enormously increased numerically and has spread at a rather rapid rate.

These details are given that you may understand the plans set forth in the following:

Life History and Habits

The life history and habits need be treated only briefly to make the problem of control understandable. The total life cycle is one year,[3] most of which time is spent in the soil as an egg, grub, or pupa. Having passed the winter in the soil, 2 to 10 or 12 inches below the surface, the half to nearly full grown grub returns to near the surface in late March

[1] I wish to take this opportunity to express my appreciation of the continuous support and help given by Doctors Headlee and Quaintance and the valuable assistance of Mr. C. H. Hadley who has always been ready to help on any phase of the work.

[2] $4,800 was made available previous to July 1, 1919, the remaining $5,200 being available for the fiscal year ending July 1, 1920.

[3] The life cycle is identical with that of certain of our *Anomolas* except that the beetles of *Popillia* are present over a much longer period.

or early April and resumes feeding. The older larvæ complete their growth by early June when they prepare earthen cells in which they transform to the pupa and about two weeks later to the adult. Previous to pupating the grub is in the prepupa or dormant stage for a period of a week or ten days, and after transforming to adult it usually remains in the cell another ten days to two weeks before coming out of the ground. Like the related leaf chafers this insect pupates within the larval skin, the skin splitting along the back almost the entire length.

The first beetle issues the last of June and the maximum period of emergence is during the latter part of July. The life of the individual beetle varies considerably, averaging from one to ten weeks, but beetles occur over a period of about four months, abundantly over a period of two to two and one-half months.

After issuing the beetles feed for several days to a week before mating. Mating and egg laying is continued at irregular intervals, the eggs being laid by preference in uncultivated places such as grassy fields or grassy and weedy areas along roadways, in moist but not swampy ground, and in soil rich in humus, each beetle laying an average of 60 eggs. The young grubs hatching from the eggs some two weeks later feed on decaying matter in the soil and to a less extent on living plant roots and late in fall they form earthen cells, in which they pass the winter.

The beetles are omnivorous, resistant to unfavorable conditions, strong fliers, and very active during warm, clear days. While they may remain above ground on plants during the night they usually feed only during the day; they are sluggish in cool or damp weather, but exceedingly active on warm, sunshiny days and fly quickly at the least disturbance, seldom going far into thickets, except on the outside foliage and never, from our observations, do they go into woodland or lay their eggs within wooded areas. They prefer grassy or weedy ground, unshaded by thickets or trees, to lay their eggs, and favor moist loamy soil in preference to dry sandy soil or swampy areas.

Importance as a Crop Pest

The insect is not injurious in the grub stage, partly because the grubs are actively feeding at a time when crops are least likely to be injured and partly because they feed as freely or more so on decaying matter as on living roots.

The beetle is a serious menace to small fruits, orchards, cereal and forage crops and to ornamentals. It is almost omnivorous, feeding, according to our records, on more than 120 plants. It feeds on weeds and wild shrubs of many kinds, such as smartweed, elder, sassafras

and grape, small fruits such as grape and blackberry, orchard fruits including apple and sweet cherry, ornamental shrubs, particularly althea and rose, flower garden flowers of all kinds, field crops such as clover blossoms, soy beans and corn, and shade and timber trees including linden, birch, oak, elm and horse chestnut. The beetle does not defoliate, but rather skeletonizes the leaves which often turn brown and drop off. In this way grape vines are riddled, entire orchards of apples appear brown because of the injury, even shade and timber trees are similarly browned to the tops. Clover flowers are eaten and the silk of corn cut off in such a way as to prevent proper fertilization and there is every reason to believe that injury to these crops can acquire a considerable importance. The insect is not, according to Professor S. I. Kuwana, a pest of great importance in Japan, although it does occasionally damage grape and soy bean, the latter especially. The fact that this beetle is of little importance in its native home only indicates that it is there held under reasonable control by natural conditions or natural enemies, or both. The data at hand indicate that the species has every ability to be a pest of prime importance to the agricultural interests of almost any community where it becomes established unless held sufficiently in check by natural enemies.

Difficulties of Control

The insect is a strong flier, very active, easily carried in vehicles, on one's person and on marketable foodstuffs, flowers, etc., as has been repeatedly demonstrated, feeds on a large variety of crops including the lowest growing plants to the largest timber trees, spends a greater part of its life underground where it is difficult to reach, multiplies with remarkable rapidity and lacks its native natural enemies. For these reasons and because it has become so firmly established, because the conditions in Burlington and Camden Counties, New Jersey, where it occurs are so favorable for the insect,—the headlands, fence rows, creeks, and roadsides being grown up and forming a network of favorite food plants and breeding grounds—and finally because the beetle is only moderately affected by poison and is strongly repelled by practically all arsenicals, the species is difficult to control and apparently impossible to eradicate without the expenditure of very large amounts of money. Prevention of spread is difficult, but not impossible and with the plans now under way and a quarantine service, as anticipated, we have every reason to believe that spread another season will be appreciably minimized.

Limits of Infestation

The green Japanese beetle is known to occur in the United States only in portions of Burlington and Camden Counties, New Jersey.

There is a possibility that beetles have been carried out and become established outside of the known infested area, but the limits of the infested area are as nearly accurately known as the most careful study by competent men can make them. This conclusion is reached because: (1) Throughout the season of beetle flight experienced men were kept continuously scouting the outskirts of the known infestation and constantly making beetle collection excursions into the outlying territory;[1] (2) Every report of supposed Japanese beetle occurrence outside of the area, both in New Jersey and Pennsylvania, was traced out but with negative results in every case; (3) Areas of favorite food plants on the west side of the Delaware river in Pennsylvania were carefully scouted for the presence of the beetle just after the close of the period of maximum spread without finding the beetle; (4) This imported beetle has been well advertised by the distribution of colored poster charts, newspaper articles and specimens themselves in all sections of the United States and Canada and regardless of this publicity we have received no report of the occurrence of the beetle outside of the reported findings in New Jersey and Pennsylvania, all of which were investigated as already noted.

The area known to be infested is now about 15,000 acres as compared with 4,000 acres or more in 1918 and the rate of spread during the past season has averaged about one mile with a maximum spread of three miles in any one direction. The beetles began to issue the last of June and reached their maximum abundance early in August and although they were present until the last of October this past year the date of maximum spread was August 30.

Object and Plans

Owing to lack of the necessary funds and for other reasons already noted plans for eradicating the green Japanese beetle have been laid aside. Our project is now to control the bettle and to prevent, so far as possible, the further spread of the insect and at the same time to discover practical control measures and introduce the natural enemies from Japan.

Methods of Accomplishing These Objects

1. The Introduction of Native Natural Enemies is a logical undertaking and plans are being made to send a thoroughly equipped entomologist to Japan to spend not less than a year in that country studying the conditions in relation to the beetle, the parasites attacking

[1] Accurate records of beetle occurrence were kept by using maps printed on cross-section paper, the perpendicular lines lettered and the vertical lines numbered; thus in the notes a record at A25 shows that the beetle was found within an area of 264 feet of where vertical line 25 crosses perpendicular line A.

it and sending to this country such parasites as may be practical. Although the Japanese entomologists know nothing about the parasites of *Popillia* in Japan, we know that white grubs, so called, all have their insect parasites and it is reasonable to assume that *Popillia* is not an exception, and that effective parasites, probably digger wasp parasites of the grub, will be found. We already have one good example of white grub control by an introduced parasite, namely *Anomola orientalis*, which is reported to be well under control in Hawaii following the successful introduction of a digger wasp (*Scolia manilæ*) from the Philippines. Incidentally it might be mentioned that through the coöperation of Mr. Otto Swezey we received from Hawaii this past fall living *Scolia manilæ* adults and while these wasps paralyzed the grubs of *Popillia* they did not oviposit thereon.

In addition to insect enemies from the home of the Japanese beetle, it is planned to establish a large colony of English pheasants, which we know to be very fond of this beetle.

2. To Prevent Spread is of paramount importance and we hope to accomplish this by quarantine, educational measures, roadside clean-up, barrier band and the reduction of the insects in the heaviest infested areas.

(a) *Quarantine.* Since it was known that the beetles frequented corn fields and concealed themselves beneath the husks of corn, thus affording easy means of carriage to outlying districts without being noticed, a quarantine covering green corn was effectively enforced in 1919. The quarantine was fully justified and observations illustrate the importance of a stricter quarantine next season. A quarantine requiring a strict certification of all foodstuffs and other products likely to carry the beetle is anticipated. The quarantine service will be fully treated in a paper by Mr. Hadley who had charge of this phase of the work the past season.

(b) *Educational Measures.* By educational measures, meetings, neighborhood discussions and personal contact it is planned to familiarize the residents of the infested area and that surrounding with the insect and to secure their coöperation in taking every precaution when traveling out of the infested territory and especially to discourage the carrying out of flowers and plants during the beetle flight and plants with soil at all times. Circular letters containing information on the work, our progress and plans and timely coöperative suggestions are mailed to the residents of the infested and surrounding territory about once a month and these together with the meetings have done much to secure the needed coöperation.

(c) *Roadside Clean-up.* To minimize the chances of beetles entering vehicles and thus being carried out, the roadsides throughout the beetle

area and that surrounding are being cleaned up. This clean-up work consists in cutting all wild shrubs and small trees along roadsides and back about 10 feet on either side. After cutting the brush is piled, oiled if necessary, and burned. For these purposes the implements most useful are the bush scythe, axe, bush hook, bush axe, hay fork and manure hook. In cases where the vegetation is dense and especially where it consists of briers and berry bushes, difficult to clean out by hand, it is burned direct, using a fuel oil flame. Such a flame produced by forcing the oil through the spray nozzle, preferably one giving a fine, fan-shaped spray, is intense and very effective in burning standing green vegetation.

This work is being rapidly pushed this winter and next spring it is planned to salt these cut-over areas, using salt at the rate of about three tons per acre, to prevent a regrowth. According to Mr. W. Rudolfs, research student at Rutgers College, who is making a special study of the uses of salt for agricultural purposes, the salt acts as a destroyer of plant life when it is broken up into its component parts and the chlorine taken up through the roots thus poisoning the plants and preventing the proper functioning of the plant cells. Consequently the salt applications will be most effective when applied in spring as plants are actively growing and when a rain follows shortly after the application. Heretofore we have used arsenical weed-killers and while they are quite effective they have the disadvantage of making the vegetation poisonous to cattle, which is a serious objection as anyone who has had experience with control projects will agree.

(d) *Barrier Band.* It has been planned to construct a so-called barrier band completely around the area extending at least one-half mile beyond the exteme limits of known beetle infestation. In this band it is planned to cut, burn and salt all roadsides, headlands, fence rows, brushy woodlots, creek banks, in fact every area where wild vines and shrubs were growing excepting timber patches and to make it as free from favorite feeding and breeding places as practicable, and in addition to make this area undesirable for the beetles by keeping the remaining vegetation thoroughly coated with a repellent during the beetle flight. Heretofore a dust of arsenate of lead and lime (20–80) has been used, and while this material is an effective repellent it is poisonous to animals and on account of the scattering pasture lands a complete band could not be maintained. Sulphur and lime as a dust and lime-sulphur solution will hereafter be used as they are very effective repellents and are not poisonous to cattle.

As long as the extensive headlands, ditch banks, fence rows, etc., continue in their present condition, that is, grown up with favorite food plants of the beetle, thus forming a network throughout and

extending beyond the infested area, the beetles will continue to have ideal and easy means of traveling out and establishing themselves in new areas at a rapid rate. With these favorite food plants eliminated the beetles find it much more difficult to spread and there is far less opportunity and chance of their entering vehicles or fruit and vegetable packages and in this way being carried away. A scarcity of favorite food plants and breeding areas naturally interferes with the unrestricted multiplication of the beetle, and likewise such conditions will also make it necessary for the beetles to concentrate on fewer plants and in fewer places, thus making the hand collecting of beetles more profitable and the scouting more efficient.

In this connection the War Department was requested to coöperate to the extent of mapping the area, the object being to photograph and prepare a mosaic of the area from an aeroplane, to enable us to plan our clean-up to better advantage and to impress more clearly upon the farmers the needs of clean-up work on their individual farms. The War Department detailed an outfit for this purpose, but owing to the foggy conditions and equipment unsuited for these conditions satisfactory photographs were not obtained, but the work will probably be repeated next spring under more favorable conditions and with equipment better suited for our needs.

For the entire project it was estimated that a minimum of $70,000, in addition to the funds already appropriated, would be necessary and consequently this amount was requested. Of this amount $45,000 were granted and since it is impossible to construct and maintain a barrier as planned we are now endeavoring to secure the coöperation of the individual farmers to clean up according to our directions. Whether the coöperation will be sufficiently general to enable us to complete and maintain the barrier cannot be foretold.

3. To Reduce Their Numbers it is planned to continue hand-collecting the beetles, cyaniding to destroy the grubs and to secure the coöperation of farmers to the extent of following certain agricultural practices.

(a) *Hand Collecting.* The past season collectors were employed to collect beetles in the heaviest infested areas, but only at such times as when inspection and similar work permitted. Boys were encouraged to collect beetles for which we paid 60 cents a quart (average 3,376 beetles) early in the season and 80 cents later on. In this way we destroyed approximately one and one-half millions of beetles, at least 40 per cent of which were females. Hand collecting is believed to be very profitable, especially since the use of arsenicals is impractical, from our present knowledge, and this method will be pushed another season.

(b) *Soil Insecticide Operations.* Soil insecticide tests using sodium cyanide as the insecticide begun by Mr. Goodwin in 1918 have been continued and the amounts and methods of application are now quite satisfactory, giving us a kill of 90 to 100 per cent. The equipment consists of 600-gallon tanks drawn by caterpillar tractors. The flow is by gravity through 3 inch pipe with $\frac{3}{8}$ inch holes, 48 holes to a foot, and covers a strip $7\frac{1}{2}$ feet wide, the flow being governed by a gate valve, which can be operated by the tractor driver. The rate of applicatiou which has been found quite effective is 165 pounds of granular sodium cyanide in 12,000 gallons of water per acre. The cost of the insecticides and labor necessary is approximately $56 per acre and is too expensive for general use, but for small areas and in the case of the green Japanese beetle for large areas where the grubs are abundant and where larger expenditures are permissible from the standpoint of controlling an insect occurring only in a comparatively small isolated locality. To determine the area of heavier grub infestation and the fields sufficiently infested to be cyanided, individual square yards in different parts of the field are examined. For this purpose a hazel or grub hoe with a thin blade is very useful.

In cyaniding, Mr. Hadley, who had charge of the soil insecticide work this fall, found that three tanks and two tractors can work most economically. Two men drive the tractors while one remains at the filling station mixing cyanide and filling the extra tank. As one tank is emptied, it is hauled to the filling station and a filled tank taken out. In this way the two tractors and three men lose no time and the three tanks are capable of covering three acres per day, that is, each tank treats one acre per day applying in this time 12,000 gallons of liquid. The water used in this work must be obtained largely from creeks nearby, and is pumped by a centrifugal pump. Along roadways where it is not possible or desirable to block the road two stand pipes are used, but in a field where it is possible to haul the tanks on either side of a pipe only one water pipe is needed.

The important points in applying cyanide are that the holes be sufficiently small to allow a uniform screen of water which will quickly and thoroughly penetrate the soil, that the grubs be within two inches of the surface and that the temperature of the soil be above 48° F. At the rate of 165 pounds of cyanide per acre the grass is burned, but is not destroyed except in spots where the liquid stands. At the rate of 110 pounds per acre the burning is comparatively little and while this strength gives a kill practically equal to the greater strength when conditions are optimum our observations indicate that 165 pounds gives an effective kill over more variable and less favorable conditions.

4. Experiments and Investigations. Up to the present time the

investigations have been largely studies of the life history of the insect. Observations prove that most poisons, however applied, are decided repellents and further that the beetles are not readily killed even when they feed on poisoned foliage. A few experiments conducted the past season show that certain essential oils, especially lemon oil, and certain fruity or fermentation odors are attractive to the beetles, but when added to a spray solution the attractive odor usually disappears as soon as the spray dries. There is every indication that iron arsenate in solution has an attraction for the beetles, but it is not sufficiently poisonous to kill the beetles, although it is believed that a combination with another poison which will retain the attractiveness and be an effective posion can be obtained.

Coöperation

To accomplish the control of the green Japanese beetle the thorough coöperation of all residents of the area is essential. Coöperation is asked to the extent that they (1) use every care to prevent the accidental spread of the insect in vehicles, on one's person, with flowers, food products, etc., (2) clean up all headlands, fence rows, ditch banks, scrubby woodlots, and roadways on their premises, (3) hand collect beetles wherever possible, (4) plant wide row crops so far as possible and keep them thoroughly cultivated and plant a minimum acreage of green corn, because the beetles can be carried so easily on this crop, (5) to adhere strictly to the quarantine regulations, (6) to plow infested ground in the fall and to plow or deeply cultivate infested ground as thoroughly as possible in late May and during June when the grubs are transforming from grub to pupa and from pupa to adult.

REPORT OF THE SOUTHERN NURSERYMEN'S ASSOCIATION

By Paul C. Lindley, *Vice-President, Pomona, N. C.*

Mr. Chairman and Gentlemen:—

At the annual meeting of the Southern Nurserymen's Association at Atlanta the past August, a committee was appointed to report on uniform inspection regulations for all states.

The entomologists present at the Nurserymen's Convention advised that this report be presented at their annual meeting in St. Louis. The executive committee of our Association was unable to persuade one of our orators to meet with you, I suppose the "14 Points" in the report, coupled with the fact that uniform law must be an old story at your meeting, he feared to open the subject again.

The following is the report of committee:

COMMITTEE REPORT ON UNIFORM NURSERY INSPECTION REGULATIONS, FOR DECIDUOUS NURSERY STOCK

Your committee appointed for the purpose of looking into the matter of attempting at least the formulation of Nursery Inspection Regulations that may be adopted by all the states of the union with the idea of simplifying things, called into their session yesterday Mr. Lewis, State Entomologist of Georgia, Mr. Bentley, State Entomologist of Tennessee and Mr. Starcher, State Horticulturist of Alabama After a full discussion it is our opinion that the following regulations could be adopted by all the states:

1. All inspection certificates to expire August 31 of each year.
2. All nurseries must be equipped for fumigating, or dipping, or must fumigate, under permit, with some one who has proper fumigation or dipping equipment, and must fumigate or dip all nursery stock subject to San José Scale, and Aphis attack, when required by state laws or requested by purchaser
3. A printed copy of certificate of inspection must be attached to each shipment, said certificate to be printed on shipping tags.
4. All shipments must be marked to show names and addresses of consignor and consignee.
5. Attached to each container of shipments of nursery stock a certificate of fumigation or dipping when said shipments have been fumigated or dipped.
6. A duplicate copy of certificate of inspection must be filed by all nurseries with the official State Entomologist or other designated officer in each state.
7. A statement that the nursery is equipped for fumigating or dipping, or has made arrangements for this work under permit with some one properly equipped, must be filed with each State Entomologist, or other designated official.
8. The importation of five leaved pines be prohibited
9. The importation of currants and gooseberries be prohibited, except by special permit.
10. The importation of citrus stock be prohibited, except as provided for by citrus regulations.
11. That hardy greenhouse stock be included in the regulations.
12. The importation of barberries except as permitted by Federal Horticultural Board be prohibited.
13. That the license fee either for nurseries within the state or outside the state be eliminated.
14. That the Southern Nurserymen's Association pledge itself to aid in every possible way the passage of the necessary state laws providing ample funds for the support of the entomological work in each state.

Respectfully submitted,

O. W. Fraser,
E. W. Chattin,
Paul C. Lindley,
Charles T. Smith,
H. B. Chase, *Committee.*

1. All inspection certificates to expire August 31 of each year.

A date not later than September 15 should be agreeable to all states, if August 31 is too early. Quantities of coniferous evergreens are moved in August. The earlier date is more convenient for the trade on account of delay in getting their printed matter.

2. All nurseries must be equipped for fumigating or dipping.

Both good, if I were planting an apple orchard would prefer and want the trees dipped. For several years we have dipped our apple scions in soluble oil before grafting with good results.

6. On receiving and filing our signed duplicate certificate of inspection, giving us the right to ship nursery stock to any state where we conform to their laws, what more should be necessary?

There is just one point I want you gentlemen to seriously consider when your inspector visits the various nurseries in their respective states. Provide him with a blank report to file with all state officials giving condition of stock, if any cutback seedling peaches or nut trees, seedlings in yearling blocks of trees In this way each state would have a report of all nurseries and a little watchful waiting I believe would clear up what is said to be some bad nursery practices.

10. The group of citrus states will have their separate regulations in addition to the uniform law.

13. License Fees.

Works hardship on all nurseries having sometimes only one order to a state. Puts the little fellow out of business. We have quite a lot of requests for catalogues from states adjoining the South Atlantic group, but on account of the laws all we can do is to write them a letter and tell them on account of prevailing state laws, we can't ship to their state. The nursery interests will help you get more revenue from other sources as outlined in article No. 14

Numbered Tags

While sent here by the entire Southern Association it is the retail nurserymen who are specially interested. For the wholesale nurserymen whose shipments consist of bulk cars and several boxes for each individual order, numbered tags have no worry.

It is humiliating and rather embarrassing to be brutally frank in regard to a group of nurserymen in one of our southern states, which is the cause of laws in the states of South Carolina and Mississippi that a numbered tag shall be on each package, box or bale and copy of order filed in few days with the state officials. Now if this law is necessary in the states of South Carolina and Mississippi, why isn't it necessary in all states?

Returning to the states of South Carolina and Mississippi—there is only one nursery in South Carolina and I don't know of any in Mississippi doing a retail business. Most certainly the officials in charge should protect the people, when practically all trees come from *other* states. The only way of knowing in what districts certain nurserymen are working is by the copy of each order required on day of shipment.

Now, gentlemen, please don't get the impression that I am arguing against your laws, for I approve of all but one of them. I will try to show you why the Southern Nurserymen belonging to the Southern Association do not like numbered tags.

I will take my firm and endeavor to show our methods of filling an order. Our orders come in during the summer before we have a certificate and are tagged as follows: All fruit trees on one tag that goes to that department. If shrubs are ordered the same number is used but different tag. Different departments handle the grape, roses and strawberries, and are shipped from one of our branch nurseries eighty miles away. Pecans are tagged separately and shipped direct from Florida. We usually ship several thousand orders and have only 30 days to do the work. We were forced to put on extra help to take care of the tag end of the business. Along would come a countermand, and perhaps the customer had purchased only nut trees and his number was in Florida, or if only roses and berries, at our branch nursery. Quite a lot of red tape and very costly in *time* during the fall shipping season

If all the states in which we do business required a copy of each order and a numbered tag, we would discontinue our agency business. We had one delivery of several hundred orders at one point in Mississippi this season. It will give you some idea of time to wire a tag to each order and stamp the duplicate number on our tag and the duplicate to go to the state department. Now one of our best men has to oversee the new girls doing this work or it will be balled up and we get "bawled out."

Now this same group of nurserymen, who I judge is the cause of our tag law, do not belong nor can they join our Southern Association if they wished. I was informed by one of our state officials that he saw a shipment of acre orchards in which the peach were all labeled different varieties, but the trees were dormant buds and part of the buds dead. They also agree to spray and trim for certain length of time. Do numbered tags correct this evil? We have laws against frauds, can't our state officials handle such practices under that act?

Cooperation

You are directly interested in the fruit business and we trust your organization will support measures for the benefit of the nurseryman as well as the planter.

The buyer whom you are trying to protect would purchase few trees from a catalogue, but waits for the annual trip of the tree salesman. Though there are many crooked ones, taken as a whole they have been a blessing. I know of one man who has worked the same town and county in Alabama for thirty-five years. Usually, though, a great number of them do not return after the trees begin to fruit.

Not all mistakes are made by the much cussed tree agent or the nurseryman. During the past few years inefficient and short supply of labor have been the cause of many mistakes. Cutting buds and careless handling by irresponsible workmen causes many mistakes; especially is this so with the peach. The peach is the hall-mark of the crooked nurseryman. He can mow off the seedlings with a mowing machine and give them the appearance of budded stock, can bud them and if a bud dies, let a sucker come or just plant a block of seed and cultivate them. I know of one block of peach the past season that, owing to a poor stand of buds, contained many thousands of seedlings that looked like first class trees at digging time. When that block of trees were shipped the weather was bad, they were ordered out by wire, consequently the purchaser received many hundreds of seedling trees. I believe that nurseryman intended to be honest but was keeping his overhead expense down by employing inferior labor during his busy season.

Conclusion

What shall we do?

Now what will the nursery interests represented by the Southern Association do if we have a uniform law? Article VII of their Constitution says:

"It shall be the duty of every member to report to the executive committee hereof, any character of dealings on the part of Association members not in accord with established business ethics. The secretary shall once each year provide each member with blanks for ballot, upon which he shall make a report, and in case any member shall receive three or more adverse reports, the executive committee shall immediately make such investigation as will develop all the facts in the case, and bring their report before the next annual meeting of this Association. If, upon evidence deduced, it is proven that such members' dealings violate established ethical relations, he shall be expelled from this Association upon a majority vote of the members present at any annual meeting, provided each member shall have the right to be heard in his own behalf before such action is taken."

Sometimes it is a hard proposition and a serious one to be able to determine whether

the nurseryman is crooked or whether the people who accuse him are trying to get something for nothing when they say unfair dealings. But if any state official will report to our secretary any nurseryman who ships say peach with nematode roots and will not adjust the matter satisfactorily to all concerned, the Association will try to see that both parties have a satisfactory adjustment.

Coöperation is the order of the day and we want to help you.

Teach your inspectors to be a help in place of a scare. A few years ago the nurserymen growing fruit trees were in the clutches of an epidemic "the jumps" on receipt of a postal saying the inspector would arrive on a given date. They should look for seedlings as well as scale, and give the nurserymen helpful criticism, in order that they may improve their methods.

THE GREEN JAPANESE BEETLE QUARANTINE[1]

By C. H. Hadley, *Riverton, N. J.*

The primary purpose of any insect quarantine is the prevention of its further spread, but before any quarantine can be imposed, a thorough study of the insect in question is of course necessary, with particular reference to the conditions which may cause, aid, or restrict, directly or indirectly, distribution and spread of the insect. Since a discussion of the green Japanese beetle problem as a whole has already been given at these meetings, it is only necessary here to give a brief statement of the conditions which necessitated the placing of this quarantine.

It is known that the green Japanese beetle (*Popillia japonica* Newm.) was accidentally imported into Burlington County, New Jersey, from Japan sometime previous to 1916, probably as a grub in the soil about the roots of perennial plants. It was discovered during the month of August, 1916, by inspectors of the New Jersey State Department of Agriculture. Observations during the seasons of 1917 and 1918 showed that the insect was capable of reproducing at an amazing rate, and unless soon checked would, undoubtedly, develop into a pest of very considerable importance. It was further ascertained that the danger of the insect being carried from the infested territory on farm produce, especially green or sweet corn, was very great. Accordingly after necessary public hearings were held, quarantine order number 35, restricting the movement of green, sweet or sugar corn interstate from the infested districts, was published by the Secretary of Agriculture, to be effective June 1, 1919. This quarantine was shortly after supplemented by a similar measure, promulgated by the Secretary of Agriculture of the state of New Jersey, regulating the intra-state movement of green or sweet corn from the infested territory.

The territory designated as the area under quarantine comprised the townships of Delran, Cinnaminson and Chester, all in Burlington

[1] Published by permission of Secretary of Agriculture.

County, New Jersey. In addition to this territory, the intra-state quarantine order included the township of Palmyra and the Borough of Riverton in the area subject to quarantine. The regulations also provided for the thorough cleaning of all vehicles employed in the transportation of this product. The details of the rules and regulations of the state quarantine order were identical with those of the federal quarantine, already in force, and their enforcement delegated to the representative of the state already attached to the green Japanese beetle force. In effect, the representative of the Federal Horticultural Board was directly responsible for the enforcement of both quarantine orders without further distinction.

In enforcing the quarantine regulations, the following methods of precedure were adopted. Early in the spring of 1919, a questionaire, together with a map of the infested territory on which the location of the farm could be indicated, and a copy of the regulations, were sent to every resident of the quarantined area who owned or rented five or more acres of land. In this way it was possible to determine what farms were growing sweet corn, what proportion was intended for home consumption and what for sale, where it was to be shipped, location and other data of importance in carrying out the provisions of the quarantine.

This territory was roughly divided into three districts, (1) including those farms within the quarantined area, but well outside the known limits of infestation; (2) those farms within the probable limits of infestation, but not as yet actually infested; and (3) those farms known to be actually infested.

For the first district, "blanket" certificates were issued to each farmer growing green or sweet corn for sale, allowing unrestricted shipment of their product up to August 15, or until revoked for cause. It was expected that the limits of a possible spread of the beetle would be known by that time, and after that date the certificates were extended for the balance of the season, except where circumstances did not warrant such action for individual cases.

For the second district, similar "blanket" certificates were issued, valid until July 25, or until revoked for cause. It was anticipated that by that time the outlying points of infestation would be definitely known. After that date, the certificates were extended if circumstances warranted; otherwise the farm in question automatically fell in the third classification.

For the third district, comprising those farms known to be infested in greater or less abundance, no "blanket" certificates were issued, but actual inspection and certification of every package of corn was required before it could be moved from the farm. Throughout this

locality, the practice of packing green corn in baskets holding five-eighths of a bushel (known as five-eighths baskets) is almost universal. The usual method is to cut or pull the ears in the field, pile them in a shaded place nearby, and then pack them in baskets to await shipment. Occasionally a grower has a packing shed or house in which the final packing is done. The inspection was made after the ears were piled and before packing. The inspector examined each ear, and in the case of suspicious appearing ears, the husk was torn down. It was soon learned that normal ears, on which the husk was perfectly tight and the silk uninjured in any way, offered no concealment for the insect; on the other hand, ears with a loose husk, or in which the husk was eaten by other insects (especially by ear worm), or in which the silk was eaten or missing, or ears in which the husk did not entirely cover the tip of the cob, or ears deformed by some disease or other cause, were almost invariably the ones harboring the beetle. Occasionally a beetle was found on the outside of the husk or silk, but usually any of the insects which may have been in such exposed places had been knocked off in the handling of the ears. It was noticeable that the infested ears were usually found early in the morning; apparently the beetles left their shelter as the air became warmer.

During the course of the season, something over 23,000 baskets of corn were examined, in which a total of seventy-seven (77) beetles were found, in practically every case the beetle or beetles being found beneath the husk. The corn ear worm was abundant during the past season, especially on the earlier varieties of green corn, and often their feeding places on the corn furnished hiding places for the beetles.

In the opinion of those engaged in the green Japanese beetle project, the quarantine has been abundantly justified, in the finding of these seventy-seven beetles which would otherwise have escaped from the infested territory. While apparently this number is small in comparison with the number of baskets of corn examined, these relatively few beetles assume a much greater importance when the amazingly rapid rate of increase of which this species is capable, is considered. It should also be noted that in every case in which the shipments were found to be infested, the corn was destined for the Philadelphia market, from there perhaps to be scattered in small lots to points further removed from the present infestation.

All shipments of green corn made via railroad or mail were also inspected and certified. For such shipments, special forms for certification were required.

Throughout the season, as opportunity offered, other farm products were examined, in order to determine to what extent they might serve as means of dispersing the insect. The methods in common use for

the disposal of most farm products from this district are in many instances very favorable to the further dispersal of the beetles, and those in charge of the work are convinced of the need of additional quarantine measures, to remedy this situation. Not only will the area now subject to quarantine need to be very considerably enlarged, but it seems probable also that the shipment of practically all outdoor grown farm products will have to be subject to quarantine regulations. A revised quarantine measure is now being drawn up, which we believe will fully and adequately cover all phases of the situation, so that the chances of further spread by this means will be reduced to the very minimum.

At 3.40 p. m., the meeting of the Association was called to order.

President W. C. O'Kane: We will resume the program and the next paper is "A Preliminary Report on the Use of Sodium Cyanide for the Control of the Peach Borer," by Alvah Peterson.

A PRELIMINARY REPORT ON THE USE OF SODIUM CYANIDE FOR THE CONTROL OF THE PEACH-TREE BORER (SANNINOIDEA EXITIOSA SAY)

By Alvah Peterson, *Assistant Entomologist, New Jersey Agricultural Experiment Station*

Introduction

For two seasons we have been studying the response of the peach-tree borer and peach trees to sodium cyanide. In 1916, Mr. M. A. Blake and Mr. C. H. Connors, of the New Jersey Agricultural Experiment Station, started a few experiments with sodium cyanide. They found that strengths up to and including one ounce to one gallon of water did not injure the trees. On the basis of their results one peach grower in New Jersey, who has 3,000 six-year-old trees located on silt loam soil, has treated his orchard for three seasons with sodium cyanide. He applies three quarters ounce to one gallon of water to each tree in September or October. During the past season one ounce of dry sodium cyanide per tree was applied. This orchard today is in excellent condition and the peach borers have been greatly reduced.

In experimenting with poisonous gases or materials for the control of the peach-tree borer some of the important points to consider are the size and location of the larvæ in the tree, the age and condition of the tree, the time and method of application, the penetrative and lasting quality of the poison in the soil and the physical and chemical properties of the soil, particularly its temperature and water holding

capacity. Many of the above phases of the problem are closely related, consequently it is by no means a simple one.

Method of Application

The granulated or liquid sodium cyanide was placed in a shallow trench (2 to 4 inches deep) about the base of the peach tree. After the poison was applied the soil was piled up about the tree to a height of 6 to 10 inches and then tramped down with a hoe. In the liquid treatments (sodium cyanide dissolved in water) the solution was permitted to partially soak into the ground before the dirt was piled about the tree. When the dry granular sodium cyanide was used it was evenly distributed in the trench and not permitted to come directly in contact with the tree.

Response of the Larvae to Sodium Cyanide

What is the minimum dosage which will kill a sufficient number of larvæ to be a practical control (Tables I to II)? In this preliminary report three typical experiments will be discussed. These are taken from a number of experiments conducted under varying conditions in eight orchards throughout New Jersey. Table I shows the results obtained at Clementon, N. J., early in November, 1918, where experiments were conducted under two soil conditions, a light sandy soil and a gravel loam soil. In these experiments the percentage of kill is based on an actual count of the dead and living larvæ found in the treated trees. The percentage of dead larvæ is probably greater than indicated, because in "worming" the trees one cannot be sure that all of the dead larvæ have been found. A dead larva gives no indication of its presence in a tree while a living larvæ does. To remove all of the dead borers would require severe cutting of the trees.

Table II shows the results obtained at Clementon, N. J., in May, 1919. The percentage of reduction in the infestation is very similar to that obtained early in November, 1918. In this table the per-

Table I. The Effect of Sodium Cyanide on Peach-Tree Borers (per Tree) Present in Nine-Year-Old-Trees (Five Trees in Each Plot) in November, 1918, at Clementon, N. J.

Series	Treatment	Living larvæ per tree	Dead larvæ per tree	Total larvæ per tree	Percentage killed
1	½ oz. to 1 gal.	1.6	3.4	5.0	68%
2	1 oz. to 1 gal.	.4	5.6	6.0	93%
3	Check	10.6	0	10.6	
4	1 oz. to 1 gal	1.2	3.6	4.8	75%
5	1½ oz. to 1 gal.	4	6.4	6.8	94%
6	1 oz. dry	8	2.8	3.6	77%
7	Check	5.0	0	5.0	

Series 1–3 in sandy soil.
Series 4–7 in gravel loam soil.

Table II The Effect of Sodium Cyanide on Peach-Tree Borers (per Tree) Present in Nine-Year-Old Trees in May, 1919, at Clementon, N. J.

Series	Treatment	Larvæ per tree (alive)	Reduction (percentage)
A	1 oz. to 1 gal	1.6	68%
B	1½ oz. to 1 gal	0.6	88%
C	1 oz. dry	1.0	80%
D	1½ oz. dry	0.0	100%
E	Check	5.0	

Series A-E in gravel loam soil

centage of kill is based on a comparison of the number of living larvæ removed from the treated and check trees. Heavily infested trees were chosen for these experiments.

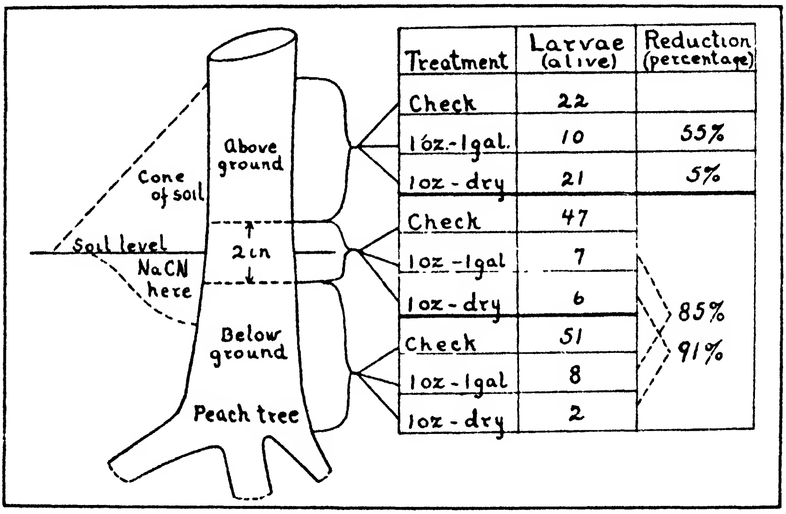


Table III. The effect of sodium cyanide on the total number of larvæ found in the three zones of trees (8 years old). Oct. 1. 1919, Middletown, N. J. Sandy loam soil. Ten trees in each plot.

Table III shows the results obtained October 1, 1919, at Middletown, N. J. Twenty heavily infested trees were selected and treated in this severely infested orchard, ten trees with one ounce of sodium cyanide dissolved in one gallon of water for each tree and ten trees with one ounce of dry sodium cyanide sprinkled in a shallow trench about each tree. When the larvæ were removed, their condition, size and location in the tree was noted. The diagram shows the tree divided into three zones, the top or above ground zone extending from one inch above the soil level upwards and the bottom or below ground zone extending from one inch below ground downwards to and including the base of the large roots. The intermediate zone, where the greatest concentration of larvæ was found, may be called the soil level zone.

The one ounce treatments reduced the living larvæ 85 to 91 per cent in the soil level and below ground zones while above ground the sodium cyanide was not very effective. The dry sodium cyanide did not materially effect the larvæ above ground while the liquid sodium cyanide apparently did (55 per cent). This difference may be due to the fact that in applying the liquid sodium cyanide the poison was poured against the tree above ground. It is probable that a greater percentage of kill above ground would have resulted with the dry sodium cyanide if it had been sprinkled about the tree at soil level and not placed in a trough 2 to 4 inches deep.

The size of the larvæ is not recorded in the tables, but our records show that small larvæ are killed more readily than larger ones. This may be due to the fact that the small larvæ are usually located near the outer surface of the trunk while the large ones may be deeply embedded in the tree. In early autumn the majority of the larvæ are small and located near the outside of the tree. This points to the conclusion that the best time of the year to kill the borers is during September or early in October.

Response of the Peach Trees to Sodium Cyanide

What is the maximum dosage peach trees of varying ages will stand? In Tables IV and V a few of the typical and unusual results are recorded from various orchards. Table IV shows the results obtained with eight- and nine-year-old trees. Two and three ounce treatments killed or injured many of the trees when applications were made in May and June. Similar applications made in October gave the same results. When one and one half ounces and one ounce treatments to a gallon of water were applied in November, 1918, to eight-year-old trees in a gravel loam soil all of the trees died which received one and one half ounces and 20 per cent died which received one ounce. A one ounce dry sodium cyanide treatment was made at the same time and no tree was seriously injured. In the same orchard a number of

Table IV. The Effect of Sodium Cyanide on Peach Trees Eight and Nine Years of Age, 1918–19

Treatment	Date	Soil	Normal trees	Injured trees	Dead trees
½ oz to 1 gal	Oct 29, '18	Sandy	5	0	0
1 oz. to 1 gal.	Oct 29, '18	Sandy	5	0	0
1 oz. to 1 gal	Nov. 10, '18	Gravel loam	4	0	1
1½ oz to 1 gal	Nov 10, '18	Gravel loam	0	0	5
1 oz. dry	Nov 10, '18	Gravel loam	5	0	0
1 oz. to 1 gal	May 15, '19	Gravel loam	3	0	0
1½ oz to 1 gal	May 15, '19	Gravel loam	3	0	0
1 oz. dry	May 15, '19	Gravel loam	3	0	0
1½ oz. dry	May 15, '19	Gravel loam	3	0	0
2 oz dry	May 15, '19	Sandy	1	2	0
3 oz. dry	May 15, '19	Sandy	3	0	0
3 oz dry	June 7, '19	Sand loam	0	0	5

trees were treated during May, and June, 1919, and September, 1918, with one half and one ounce and they were not affected. It is probable that November is too late in the year to safely treat trees with NaCN, particularly when applied in liquid form. In all our experiments with sodium cyanide a one ounce treatment (liquid or granular form) has not seriously injured or killed five- to ten-year-old trees when applied in May, June, September, or October.

TABLE V THE EFFECT OF SODIUM CYANIDE ON PEACH TREES TWO TO FOUR YEARS OF AGE, 1917-19

Treatment	Date	Soil	Age of trees	Normal trees	Injured trees	Dead trees
*½ oz dry	June 4, '19	Sand loam	3	6	2	2
*1 oz dry	June 4, '19	"	3	3	2	5
½ oz to 1 gal	July 23, '17	"	2	2	0	0
¾ oz to 1 gal	July 23, '17	"	2	2	0	0
1 oz to 1 gal	July 23, '17	"	2	1	1	0
2 oz to 1 gal	July 23, '17	"	2	1	0	1
½ oz to 1 gal	July 23, '17	"	4	2	0	0
¾ oz to 1 gal	July 23, '17		4	2	0	0
1 oz to 1 gal	July 23, '17		4	2	0	0
2 oz to 1 gal	July 23, '17	"	4	1	1	0

* Trees in this orchard (Middletown, N. J.) severely injured by winter kill (1917-18)

Table V shows the results of a few experiments with two- to four-year-old trees. The results indicate that healthy trees will stand one half to three quarters ounce of sodium cyanide without injury. Trees that have been weakened by winter kill or heavily infested with borers may be injured or killed by these strengths.

When sodium cyanide injures the trees the leaves and fruit wilt. The leaves gradually turn yellow and drop off. The behavior of an injured tree is somewhat similar to trees injured by drought. Injury, due to applications made during May and June, usually makes its appearance a week or two after the material is applied. In some instances the injury may not show for several weeks. Trees injured by heavy doses of sodium cyanide in September, October, or November, do not always show their injured condition at the time the leaves and flowers appear the following season. The trees may give rise to normal leaves and flowers and then later in the season (June and July) the leaves and fruit may show a wilted condition. This wilted condition may exist several weeks before the trees die.

SODIUM CYANIDE IN THE SOIL

So far as known the peach-tree borers are killed by the fumes arising from the sodium cyanide. The salt undergoes rapid decomposition after it is placed in the soil. One cannot detect an odor of cyanide in the soil three weeks after a one ounce application has been made and a

chemical analysis will only show a trace. In five weeks a chemical analysis of the soil fails to show a trace of cyanide. When two or three ounce treatments have been made a faint trace of cyanide (chemical analysis) will exist in the soil adjacent to the tree five weeks after the applications have been made. It was also observed that sodium cyanide disappears sooner in liquid treatments than when the dry granular material was used.

The physical and chemical consistency of the soil has some bearing upon the use of poisonous gases for the control of the peach borer, but its importance (when using sodium cyanide) has not been thoroughly worked out. Our experiments show that one ounce treatments produce a greater percentage of dead larvæ when the trees are situated in light sandy soils than when located in heavy soils. This may be due to the fact that the gas penetrates light soils more rapidly and to a greater distance than heavy soils. Heavy soils are usually water laden and this may prevent a rapid and thorough distribution of the gas. The water holding capacity of a soil may prove to be an important factor in the use of sodium cyanide and other poisonous gases.

Time of Application

The time of application is important. Our results show that applications in May, June, September, and October, give the best results in killing the larvæ and is the safest for the tree. As yet the results do not conclusively show which of these months is the best; however, I am of the opinion that the last week in September or the first week in October will probably be the best time in New Jersey. At this time all of the eggs have hatched and the majority of the young larvæ will be found on the outside of the tree or just beneath the outer surface of the bark.

Summary

Sodium cyanide is a very poisonous substance; consequently one must use extreme care in making applications. On account of the poisonous nature of sodium cyanide it is doubtful if anyone would deem it wise to make a general recommendation to peach growers for its use.

From a scientific standpoint it has been interesting to note its influence on the larvæ and the peach trees. The results obtained may give us some information on the use of other substance such as paradichlorobenzene. During 1919 we used paradichlorobenzene in two orchards, but our experiments to date are not sufficiently extensive or conclusive to give the results at this time.

One ounce treatments (liquid or granular form) of sodium cyanide will kill 75 to 90 per cent of the larvæ in five- to ten-year-old trees.

The granular or dry sodium cyanide is just as efficient as the liquid (one ounce to one gallon of water) and much easier to apply. One half ounce and in many cases three fourths ounce treatments for five- to ten-year-old trees will not kill a sufficient number of larvæ to constitute a practical control.

Vigorously growing peach trees five to ten years of age have not been injured by one ounce treatments when the applications were made in May, June, September, or October. Also healthy trees two to four years of age have not been injured by one half ounce treatments.

ACKNOWLEDGMENTS

I am indebted to Mr. C. H. Connors and Mr. M. A. Blake for valuable information concerning their results with sodium cyanide. I wish to thank Dr. T. J. Headlee for many important suggestions received. I am also indebted to a number of peach tree growers in New Jersey who have permitted me to carry on investigations in their orchards.

MR. O. I. SNAPP: I would like to ask Mr. Peterson how close to the tree trunk the material was placed?

MR. ALVAH PETERSON: In the liquid treatments, a trough was dug about the tree two to four inches deep; the liquid was poured into the trough so that it came in contact with the tree. In the dry treatment fine, granular sodium cyanide was used. This was sprinkled in the trough about the tree. The majority of the sodium cyanide would be an inch or two away from the tree.

MR. G. G. BECKER: In order to get a little more definitely at the direct state of application, I would like Mr. Peterson to tell us about the time of emergence of the moth in New Jersey, and whether the applications were used then or not.

MR. ALVAH PETERSON: For three seasons we have been studying the peach-tree borer; the first year was devoted largely to a life history study in New Jersey and also a preliminary study of various methods of control. We find that the majority of adults emerge in August. They start to come out about June 15 and some may be found as late as September 15th, but the greatest number come out the first two weeks in August. I have found eggs on the trees as late as September 20th.

We made applications in May, June, September, October and November. I am of the opinion that in using a toxic gas for killing the peach-tree borer, it would be advisable to make the application late in September or early in October. I would not put it off too late in the season due to the fact that the soil becomes cold and the larvæ

are less active; consequently, they are not as easily killed, and furthermore the poisonous material may also have some effect on the peach trees.

PRESIDENT W. C. O'KANE: The next paper is "Dust versus Spray for the Control of Sour Cherry Pests in Pennsylvania," by J. G. Sanders and D. M. De Long.

DUST VERSUS SPRAY FOR CONTROL OF SOUR CHERRY PESTS IN PENNSYLVANIA

By J. G. SANDERS and D. M. DELONG, *Harrisburg, Pa.*

The northern portion of Erie County, Pa., contains approximately ten thousand acres of fruit orchards and vineyards. In this area the growing and marketing of sour cherries is a considerable factor. Due to local conditions adjacent to Lake Erie, the usual pests affecting sour cherry, such as curculio, slug and leaf spot disease, are more or less destructive, varying considerably from year to year. In this Lake area, as was noted in similar conditions in Wisconsin, the cherry slug is unusually destructive throughout a strip four to five miles in width—adjacent to the Lake.

The damage from curculio, slug and leaf spot was exceptionally serious in 1918, and following requests for help from the growers, a series of experiments was carried on during the summer of 1919 to determine the relative value of dust and spray mixtures for pest control. Sour cherry trees six years of age, comprising four blocks, 12 trees in width and 34 in length—with a check plot 3 by 12 trees, were selected at one end of a large cherry orchard. The test plots were bounded by vineyards on the east, north and west, while the continuation of the orchard was to the southward. The remainder of the orchard—not included in the test—was sprayed three times by the owner with commercial lime-sulfur solution, 1 to 40. The prevailing winds in this section are from the southeast, blowing diagonally from the check and the remainder of the orchard, across the treated plots.

It will be noted that the first plot was treated with Bordeaux mixture, 3-3-50, with 1 pound of arsenate of lead added; the next plot was treated with hydrated lime, sulfur and arsenate of lead dust, 50–45–5; the next with lime-sulfur spray, 1 to 40; and the next with sulfur-arsenate of lead dust 90–10. Applications to all test plots were made first on May 31, 1919, after the petals had fallen; second on June 13; and third on July 19, just after the fruit picking. No dormant spray had been applied to any block of this orchard.

The advantages of the dust over the spray—from the standpoint of application—are evident in that the time of application alone, disregarding the time required for mixing, was more than double in the

case of the wet spray; also, in dusting one horse and two men required only half the time necessary in applying the wet spray with the aid of two horses and three men. The only disadvantage noted is that certain undesirable conditions of wind sometimes require a delay, and consequent loss of time.

Reference to the accompanying table shows very decided results secured by the application of all the treatments as compared with the check or untreated plot, but attention should be called to the counts of curculio damage in the check plot, which were much below the actual damage because of the previous falling of injured fruit; and it should be stated that the injury to treated plots, and consequent falling of fruit, was very slight. The records of curculio and slug damage were made from examination on June 19, just as the fruit was beginning to ripen. The examinations for leaf spot injury were made on September 19, three months later. Attention is called to the almost perfect control of slug and curculio on the treated plots as compared with the untreated plots. There was some brown rot apparent in the treated plots, but markedly less than in the checks.

Plot	No. of trees	Curculio		Leaf spot injury	Pear slug injury	
		No. infested cherries	No. cherries not infested			
Sulfur-lead dust 90–10	6	2	1240	None	None	
Lime-sulfur spray 1–40	5	8	1200	None	None	
Lime-sulfur-lead dust 50–45–5	5	1	1191	Slight	Slight	
Bordeaux spray 3–3–50 to 1 lb. lead	5	3	1536	Slight	Slight	
Check	8	441=29%	1071	Slight	No. slugs on trees 978	Leaves injured 23%

All Counts Made in Middle of Test Plots

Little falling of leaves, and scarcely any spotting, on treated plots was noted before the first week of September. Later on—September 19th—the falling of leaves on check plots was estimated at 60 to 65 per cent, and practically all the remaining foliage was badly spotted. On the treated plots, Bordeaux mixture showed at this date 30 to 40 per cent fall; lime, sulfur and arsenate of lead dust, 50–45–5, showed 35 to 45 per cent fall; lime-sulfur spray, 25 per cent spotted and little falling; while sulfur and arsenate of lead dust, 90–10, showed about 25 per cent spotting and no falling of leaves.

It is proposed to continue these experiments in the summer of 1920, but it would seem that conclusions from this summer's work would

favor the sulfur-arsenate of lead dust on account of the rapidity and ease of application and the high efficiency in control of curculio, slug and leaf spot.

Mr. E. G. Kelly: Were the cherries counted only those infested with larvæ or also those punctured?

Mr. J. G. Sanders: Both larval infested and punctured were counted together in estimating percentage.

Mr. O. I. Snapp: I would like to ask Mr. Sanders if he experienced any difficulty in getting 90 per cent sulphur on the trees. In our experience in Mississippi, we have had some difficulty.

Mr. J. G. Sanders: We had no difficulty in completely surrounding and enshrouding the trees in a cloud of sulphur. In fact, it floated to four or five rows of trees in a very slight wind.

Mr. O. I. Snapp: I thought that the fact that so much sulphur was used would make it too heavy.

Mr. J. G. Sanders: We have never experienced any such trouble either in this case or in spraying or dusting peaches or apples. If you have sufficient power, you can project the dust to a very considerable distance.

Mr. O. I. Snapp: Did you use a Niagara machine?

Mr. J. G. Sanders: We used a Niagara outfit with a 3½ or 4 engine.

Mr. E. G. Kelly: Were you using ground sulphur?

Mr. J. G. Sanders: The finest we could get.

Mr. E. G. Kelly: Did the dew have any effect upon that?

Mr. J. G. Sanders: No.

Mr. O. I. Snapp: On what date did you spray?

Mr. J. G. Sanders: First on May 31st after the petals had fallen; second on June 13th; third on July 19th just after they had picked the fruit. The application on the 19th of July after picking the fruit was the one that was intended for the leaf spot control. It resulted in thorough control work, the leaves being retained on the trees as you saw in some of the photographs.

By vote of the Association the paper entitled "Distribution of the Oriental Moth," by H. T. Fernald, was read by the Secretary.

TEN YEARS OF THE ORIENTAL MOTH

By H. T. Fernald, *Amherst, Mass.*

In January, 1907, a bulletin on the Oriental moth issued by the Massachusetts Experiment Station contained a map showing the approximate area then occupied by the insect. At that time the area was described as "very irregular in form, but as a whole extends farther

southwest from the probable center of infestation than in any other direction, and the longest distances in the territory are almost two miles in a northeast, southwest direction, by a mile and a half at right angles to this.

During the winter of 1916–17, through the kindness of Mr. L. H. Taylor, one of the deputy state nursery inspectors, this territory was scouted, with a view of learning how far the Oriental moth had spread in ten years. It was found that the territory then occupied by the insect, though still very irregular in outline, was nearly four miles in length, and nearly three miles in width at its widest point, and with an average width of nearly two miles.

The insect has now reached the ocean on the east and has extended its distribution farthest to the south and southeast from its center, though also somewhat to the north. It has hardly spread at all to the west, for some reason not at present apparent.

For a number of years the writer tried without success to obtain a parasite of the Oriental moth, which had been recorded as attacking it in China. Finally, through the kind assistance of M. l'Abbé J. de Joannis of Paris, the coöperation of M. Gaudissart of Tientsin, China, was obtained, and in 1917 shipments of parasitized cocoons of the Oriental moth were received, followed by others up to the present time. These parasites were bred out in the laboratory of the Massachusetts Agricultural College and liberated in the infested territory.

The small number of parasites received in the earlier shipments made the recovery of the insect doubtful even if it established itself, but later consignments in 1918 increased the chances of recovery, and a collection of Oriental moth cocoons made in the infested area in March, 1919, showed that about 6 per cent had been parasitized by the imported enemy. This is an encouraging showing.

The parasite is a Chrysid, *Chrysis shanghaiensis* Walk., a very representative member of the family, about half an inch long when adult. Apparently it does not attack the larvæ but is a pupal parasite, and herein has been the chief difficulty in colonizing it thus far, for the adult tends to emerge while its host is a larva about half-grown, and by the time pupation occurs, the weather is often so cold that the parasite becomes sluggish. Attempts will be made in 1920 to hold back the emergence of the parasites, by cold storage, until near the pupation time of the host, and then, if reasonably warm weather comes, the chances of a larger amount of parasitism should be greatly increased. Further studies on the life and habits of the Chrysis are now being carried on.

So far as the writer has been able to learn, this is the only case known where a Chrysis is parasitic on a lepidopteron, but no evidence has

thus far been obtained to support Sharp's suggestion that it is really parasitic on some hymenopterous parasite present, rather than on the Oriental moth itself.

By vote of the Association, an abstract of the paper by C. R. Crosby and R. G. Palmer, entitled "Some Results of the Special Spray Service Conducted in New York State," was presented by Dr. Felt.

THE ORGANIZATION OF A SPECIAL SPRAY SERVICE IN NEW YORK STATE

By C. R Crosby and R. G. Palmer

It is becoming increasingly apparent that to be most effective demonstration work in the control of insect pests and plant diseases should be conducted for the most part on the basis of a seasonal program of treatment and not by demonstrating the control of any single disease or pest nor by isolated tests of spray materials or methods of application. The object of this kind of demonstration work is to show the value of the approved seasonal program of treatment as adapted to local conditions and to the weather prevalent during the season, and to teach the growers the most effective and economical method of protecting their crops from insect pests and plant diseases. Both from an educational and financial standpoint demonstrations conducted in accordance with the seasonal program are of greater value not only to the individual but also to the county as a whole. Efficiency requires that the work be done with an organized group of growers rather than with individuals. In order to achieve this result it is necessary that sound expert advice be available and that the necessary information be placed in the hands of the growers at the time when it will be of most use to them. In an attempt to meet these requirements we have in New York state worked out a plan of coöperation between the College of Agriculture and the County Farm Bureau Associations whereby a special field assistant is stationed in the county during the growing season and conducts the work under the supervision of the Departments of Entomology and Plant Pathology.

Our present system of conducting this work is based on the plan of organization and coöperation used during the war to increase crop production by preventing losses from diseases and insects. At the outbreak of the war the New York state legislature passed a law establishing a State Food Supply Commission for the purpose of stimulating production in agriculture. In coöperation with this commission, the College of Agriculture was enabled to conduct work in protecting crops from insect pests and plant diseases. In this work the Depart-

ments of Plant Pathology and Entomology coöperated in stationing special field assistants in certain counties to coöperate with the Farm Bureau Associations.

The plan of doing this work by means of field assistants was adopted because our experiences with industrial fellowships financed by associations of farmers had shown that the greatest good can be accomplished in the control of insect pests and plant diseases by having a trained man located in a definite territory where he can become thoroughly acquainted with the local problems, can watch the crops throughout the growing season and by his intimate knowledge of conditions be able to anticipate and prevent destructive outbreaks. He also is able to win the respect and confidence of the farmers as they become familiar with his aims and methods of work.

For field assistants, young men were selected who had had technical training in plant pathology and entomology and who, as far as possible, had had practical experience in the kind of agriculture with which they had to deal. They were placed only in counties where the local demand for their services was great enough so that the local farmers' organization was willing to furnish some means of transportation within the county—a motorcycle or automobile. These field assistants worked in close coöperation with the Farm Bureau manager and thus avoided duplication of effort and utilized the Farm Bureau organization for learning the needs of the county, for arranging demonstrations, and for assistance in reaching the individual farmers in each community.

The field assistants were under the constant supervision of experts thoroughly trained and of wide experience in demonstration work. These experts not only made sure that the advice given out was sound but also that the most efficient methods of disseminating such information were followed. The field assistant was in the field practically all the time, visiting the farmers and examining the crops and was thus often able to detect the presence of injurious insects while there was still time to fight them effectively. In the case of many of our pests it is impossible to control them after the injury becomes apparent. The development of many plant diseases is dependent on weather conditions; the field assistant was able to tell when infections were likely to take place and thus advise the proper preventive treatments.

In the season of 1917 field assistants were stationed in twelve counties. On the whole this work was so successful that in the season of 1918 the New York State Food Commission, successor of the New York State Food Supply Commission, set aside ten thousand dollars for the continuation of the work. Owing to war conditions it was impossible to obtain a sufficient number of competent field assistants and

the work was confined to a single county where highly satisfactory results were obtained.

In 1919 the Extension Department of the College of Agriculture adopted the policy of conducting the work of the field assistants on a more permanent basis. The college proposed to enter into a coöperative agreement with any county farm bureau association to station in the county a field assistant during the growing season, usually a period of six months. The college paid one hundred dollars a month towards the salary, additional salary to be furnished by the local association. The Farm Bureau furnished an automobile for the use of the assistant and paid his traveling expenses while in the county and away from headquarters. The assistant functioned as an assistant to the county agricultural agent but his activities were restricted to insect pest and plant disease control work and he was under the supervision of the college. Under this agreement field assistants were placed in six counties.

For field assistants, graduate students are selected. Our experiences, both with industrial fellowships and in the work with the Food Commissions, has shown that, in general, graduate students, preferably the younger ones, are more efficient and successful in this line of work than are older persons who have become more or less settled in life and consequently opinionated. It has been generally supposed that for this kind of work, mature men would be more desirable but as a matter of fact such is not the case. Where we have been compelled to use older men not actively interested in science or where we have used graduate students who were past the optimum age for study, we have had more misfits and failures than where younger men with more active interest have been employed. This may seem paradoxical. The explanation is that the salary available is not sufficient to attract mature men of sufficient ability. It is much better for the work to employ young men of special ability in their apprenticeship stage than men of mediocre ability who have nothing better in prospect. A young man who in the course of the next ten years is likely to be occupying a five to ten thousand dollar position is much more valuable for this work than an older man who would be satisfied to take a short term appointment at one hundred and fifty dollars a month. The younger men look on this work as an opportunity to obtain first-hand knowledge of field conditions and methods and are, therefore, willing to spend the summer season for two or three years in this way, since it is a part of their training and of direct advantage to them in their life work. Furthermore, they have an incentive to do their best since if they make good as field assistants they have a better chance to obtain a good position on receiving the advanced degree;

and, moreover, they do not receive a sufficient salary to make them wish to settle down in the work permanently as field assistants.

It has been found that the efficiency of the work requires that the field assistants be under the close supervision of some person well trained and who also has had experience in demonstration work. The supervisor should be a man of tact and enthusiasm who is able to help the assistants in becoming quickly oriented in their work, in getting in touch with the growers of the county, and in coördinating their activities with those of the county agricultural agent.

In those counties where fruit-growing is a highly specialized industry, the most important feature of the work is a spray service whereby the growers are kept informed as to the proper sprays to apply and the exact time at which they should be made. In most counties the information is sent to the growers by means of a relay telephone system, always supplemented by circular letters or postal cards. In some cases, where the time factor is not so important, the telephone is not used and the circular letter employed in its place.

In western New York, particularly, where the control of apple scab is of the utmost importance, the weather is the vital factor in determining the time at which most sprays must be applied. In this region the work of the field assistants was greatly facilitated by the coöperation of the United States Weather Bureau. A special forecaster was detailed to the Rochester office from April 6 to July 10. Arrangements were made whereby he received from Washington twice daily a special long range forecast, covering the conditions most needed by the service. These forecasts were often modified by the special forecaster. At least one of these forecasts as modified by the forecaster was sent daily to each of the Farm Bureau offices where a special assistant was stationed. As a rule the night forecast is more useful, but owing to the fact that the telegraph offices in the smaller towns are closed from 8 p. m. to 8 a. m. and the message cannot be delivered until after the growers have begun the day's work, it was found necessary in some counties to rely on the morning forecast.

In order to obviate this difficulty and also to facilitate the interpretation of the forecast, it has been found advantageous to have the general supervisor of the spray service in close touch with the special forecaster at critical times. Through a personal consultation with the forecaster he was often enabled to arrive at a decision in regard to a spray warning and immediately communicate with the field assistants of the various counties by telephone. In this way the assistant had knowledge of probable rainy periods three or four days in advance and was able to issue spray warnings in time for the growers to make the applications before the rains. A striking illustration of the prac-

tical value of these forecasts occurred on May 12, when the forecast indicated that a rain was probable in three or four days. Scab infections had already occurred in considerable numbers in orchards that had not received the delayed dormant spray. A spray warning was issued calling for the application of the blossom pink spray immediately although the blossoms did not yet show pink. The rain began in the afternoon of May 16. Subsequent events showed that this was the critical application for the commercial control of apple scab in western New York this season. In orchards where the application was delayed until after the rain of May 16–17, the leaves became badly infected with scab and a serious defoliation and fall of fruit resulted. Furthermore, in these orchards, it was very difficult to keep the fruit free from later infections. Had the special forecast of the Weather Bureau not been available, most of the growers would have waited until the 19th or 20th before making the application, when it was too late to protect the foliage.

In order to have a check on the accuracy of the recommendations made through the spray service, each assistant had certain demonstration or criterion orchards in which the spray was applied at the time advised. These orchards not only served to show the value of thorough and timely spraying, but also demonstrated the soundness of the advice given. They were of great educational value in teaching the necessity of having the fungicide on the trees before rainy periods.

In addition to the criterion demonstration orchards the assistant conducted fifteen or twenty demonstrations in the control of particular insects or diseases or in the use of spray materials or methods of application. Even in these demonstrations care was taken to have the work fit into a seasonal spraying program so that the results would not be obscured in the mind of the grower by the ravages of other pests or diseases.

In the fruit growing counties the assistant devoted all of the early part of the season to orchard work but later conducted demonstrations with potato growers. In one county the assistant devoted most of his time to the problems of onion growers.

For most effective work the number of demonstrations personally supervised by the assistant should not exceed twenty-five or thirty. The number of persons receiving the spray information service need not be limited but the assistant cannot be expected to visit all the men on such a list except in urgent cases and then only on special request. If he attempts to visit any very large number of growers the demonstrations and criterion orchards are sure to be neglected to the great detriment of the work.

The criterion demonstration orchards should be selected with care.

They should be distributed throughout the county so as to represent the different climatic zones and also serve as object lessons to the growers in different parts of the county. The differences in the seasonal development of the trees, owing to topographic and climatic factors, is much greater than is usually supposed, even in comparatively small areas. In Monroe County, for instance, a difference in the time of blossoming of from one to two weeks is not uncommon in orchards less than fifteen miles apart, on a gently sloping plain,—due in large measure to the retarding influence of the cold waters of Lake Ontario. The criterion orchard should be a representative commercial orchard consisting of the varieties commonly grown in the locality. It is important that the grower should be in sympathy with the work, that he be thorough-going and careful, and that he possess a modern and efficient spraying equipment. The arrangements for the criterion orchards are usually made by the field assistant with the advice and assistance of the county agricultural agent. Much of the success of the spray service depends on the results obtained in the criterion orchards, and too much care cannot be exercised in selecting energetic and congenial coöperators.

While special demonstrations, *e. g.*, tests of insecticides, methods of application, etc., are not so important, the rule still holds that the better the coöperator, the greater are the chances of the work being successful. In all cases the coöperator should agree to follow fully the directions of the field assistant and, where it would interfere with checking results, to leave at least a part of the crop unthinned. To determine the value of applications checks are desirable, but on account of the value of the crop it is not practicable to leave many trees untreated. Where the intent is to show the value of a seasonal system of spraying in comparison with no treatment, untreated trees are indispensable and should be selected with care. Where the demonstration is designed to show the different methods of control or the use of different materials, one part of the orchard can be checked against the other. In some cases, *e. g.*, pear psylla, checks cannot be left because of the danger of reinfestation from the untreated trees.

During the past season the six assistants we had in the field traveled an aggregate of 34,343 miles, making 3,017 visits, and issued 66 circular letters with a total circulation of 18,207. It is very difficult to estimate the financial return to the growers of the counties concerned, but there is every reason to believe that the increased value of the crops directly resulting from the work would pay several times over the entire cost of the undertaking including supervision and overhead. As an indication of the growers' appreciation of the work it may be stated that for next year twelve counties have requested to enter into a sim-

ilar coöperative agreement, in spite of the fact that for the coming season the college is able to pay only fifty, instead of one hundred dollars a month towards the salary of the field assistant.

President W. C. O'Kane: We will now take up the paper by Mr. E. D. Ball and F. A. Fenton.

WHAT PER CENT OF TIPBURN IS CAUSED BY THE POTATO LEAFHOPPER?

By E. D. Ball and F. A. Fenton

The senior author in 1919[1] pointed out that the potato leafhopper was responsible for a considerable part of the injury to potatoes which had previously been called tipburn, and suggested the name "hopperburn" for this specific effect. The authors of this article in their season's work in Iowa this year attempted to ascertain what was the relative proportion of the different factors in causing tipburn. Accordingly a number of fields of potatoes at Ames were kept under continuous observation during the entire season. The number of leafhoppers was recorded from day to day, as well as the relative percentage of nymphs and adults and their position on the vines.

It was found that there was no evidence of tipburn in the fields until after the over-wintering leafhoppers had appeared, laid eggs, and the generation of nymphs had begun to develop in numbers. The marginal burning then began to appear on the older leaves of the plant and extended observations in different fields showed that the amount of the burning was proportional to the number of leafhoppers present on the particular leaves affected, that in no case did burning develop in fields where no leafhoppers had appeared or on plants on which there were no leafhoppers, nor on the upper parts of the fast growing plants. The burning first appeared on the leaves at some distance from the top and gradually progressed upward as the plant developed and in about the same ratio as its growth for a considerable time. This was found to be correlated with the time required for the eggs deposited in the young shoots to incubate and the young nymphs to develop to an effective size. It was further found that as the burning progressed to the point where the plant was weakened and growth stunted, that it gradually approached the top until finally, at about the time growth ceased, the entire plant was affected and soon succumbed.

Careful counts were kept on a number of plants and each young nymph removed as soon as it hatched. In this way the average num-

[1] Jour. Econ. Ent. Vol. 12, p. 149, 1919, and Report of the Division of Entomology, Wisconsin Department of Agric. for 1917–19; p. 76, 1919.

1. Potato plant that had been protected from leafhoppers throughout season. Photographed at time of digging when all unprotected plants in the field were dead 2. Potato plant that had been caged with large number of leafhoppers for three days. This plant was burned to a crisp. 3. Typical hopperburn injury to bean plant. 4. Portion of potato field showing type of cage used in experiments and enclosed hopperburned plant.

ber of young that were produced on a hill was ascertained and was found to be about 2,000 for the second generation or about 10 million per acre. These results were obtained on typical fields where the average egg parasitism was about 40 per cent, so that the total number of eggs deposited per hill was above 3,000.

Potato plants inclosed in cages that excluded the leafhoppers from the beginning continued to grow with green and healthy foliage until digging time, when all the rest of the plants in the field were dead. Other plants in cages in which leafhoppers were introduced developed the typical burning of the vines in the field, showing that the green condition was not an effect of the cage. Twice during the season 250 or more adult leafhoppers were introduced into a cage at a single time with the result that all the leaves were burned and brown within three of four days. Plants in large cages, into which a small number of adult leafhoppers had been introduced, did not develop the burning until nymphs appeared.

To test the relative effect of the different stages of the insect, 50 adults of both sexes were introduced into a wire gauze cylinder on a potato tip, while 50 large nymphs were placed in another. In both cases burning developed, while the check cage remained green. In one test 50 males were placed in one cylinder and 50 females in another. The females produced serious burning while the males produced none. This was so striking that it was repeated with the same result. The males have so much less feeding capacity than the females that it is not safe to conclude from this single test that they are incapable of producing burning, but it does appear to show that they are not an important factor.

In a large cage a small number of adults were introduced. In another an equal number of small nymphs. After two weeks no burning had appeared with the adults while in the other cage here and there was a hopperburned leaf. In every case one or more large nymphs were found on the burned leaves, while there were none on the others. The reason why the adults produced no burning in this cage and did in the small cylinder was probably because in the latter they were confined to a small number of leaves while in the large cage they flew from leaf to leaf at will, while on the other hand the nymphs settled down on a single leaf and remained. The cylinder in which the 50 females had burned the tip was retained after the leafhoppers were released. Each day the young nymphs were removed as they hatched. Under this treatment new leaves were put out that remained green and healthy. This experiment was repeated, except that the nymphs were allowed to remain, with the result that the new growth burned in proportion to the growth of the nymphs.

To test the effect of humidity and partial shade, plants were inclosed in cloth (nainsook) cages. Under these conditions the plants remained without trace of hopperburn until the leafhoppers were added, when they developed this trouble as in other cases. Another experiment was carried on in a shaded greenhouse where potato slips were planted in moist sand. Burning developed on the leaves on which young nymphs were placed while those that were free from nymphs remained green and normal.

These observations and tests, as well as others carried on, by no means solve all the problems in connection with the relation of the leafhopper to the burned condition, but they appear to furnish conclusive evidence that the hopperburn can be produced at will by the use of the leafhoppers and prevented as effectively by their elimination. Tipburn has never been produced artificially in any other way and all the evidence points to the fact that its appearance in a field is strictly correlated with the attacks of the leafhopper. If these conclusions are warranted then "hopperburn" as a name for the leafhopper effect on potatoes covers practically all that has formerly been designated as tipburn on this plant. Tipburn has, however, been indiscriminately used for burning effects of all kinds on various plants, shrubs and trees and the substitution of the name "hopperburn" for the specific burning of the leaves caused by the potato leafhopper is justified in the interests of accuracy.

Mr. G. G. Becker: I would like to ask Dr. Ball whether in these experiments he noticed any correlation of the amount of curly dwarf and mosaic—anything that would confirm the work that was done in Maine some time ago.

Mr. E. D. Ball: Curly dwarf and mosaic were not factors where we were carrying on those experiments.

Mr. S. B. Fracker: I would like to know whether the leafhoppers are as numerous as they were a year ago.

Mr. E. D. Ball: The leafhoppers were even more numerous this fall than they were a year ago. With such a remarkably short fall, they did not have a chance to go into hibernation as nicely as usual and that may make a difference in next year's results.

Mr. High: How long did you leave the cages out in the field? What was the approximate date you put them out and the date you brought them in?

Mr. E. D. Ball: The cages were out in the field from the time the potatoes were planted until they were harvested.

Mr. High: What time do you plant potatoes?

Mr. E. D. Ball: About the 5th of May.

Mr. Leonard Haseman: What produces the injury of either tipburn or hopperburn or the curly leaf of beets?

Mr. E. D. Ball: Those are two diseases that we know to be caused by insects and can be produced in no other way; but what produced them is a subject on which no pathologist or physiologist will even hazard a guess, so for a mere entomologist to make a suggestion would be far out of place.

Mr. Cromwell: I would like to ask what the comparative amount of leafburn was in 1919 and 1918 in Iowa.

Mr. E. D. Ball: I was not in Iowa in 1918, except in the fall of the year, when it was approximately the same as during the fall of this year. It was a little worse during the hot period of the summer, I am told, in 1919. Our potato crop in Iowa this year was nearly a failure, more so than it was the year before.

Mr. H. A. Gossard: I would like to ask Dr. Ball whether or not he ascertained to his satisfaction that the group of females were doing all the burning.

Mr. E. D. Ball: That was a point that we were not able to determine. The handling of a very minute leafhopper like this proved to be one of the most difficult problems we had ever attacked. So much individual work was required that we did not have opportunity to carry these tests farther.

Mr. W. O. Hollister: You might be interested in a little experience I had with the leafhopper on the soy bean. I had some plants in the laboratory entirely free from any organism or insect. One leafhopper placed on the central stem of a plant produced an entire wilting and the leaf collapsed in fifteen minutes.

Mr. J. R. Parker: The control has not been discussed.

Mr. E. D. Ball: Mr. Dudley's paper deals with that. I visited him this summer, and he told me that he used nicotine sprays and got almost complete control. I wish, however, that we might leave that until Professor Parrott's paper comes up.

Professor Dudley got control with tobacco solutions. I cannot give you the details, but his paper will undoubtedly give that when you have it. Professor Parrott obtained control with the Bordeaux solution. It is a fact that we had very much heavier infestations in Iowa.

President W. C. O'Kane: The next paper will be presented by Mr. W. E. Britton, on "A Connecticut Corn Field Injured by *Crambus præfectellus* Zinck."

A CONNECTICUT CORNFIELD INJURED BY CRAMBUS PRÆFECTELLUS ZINCK.

By W. E. Britton, *State Entomologist, New Haven, Conn.*

The cornfield in which this injury occurred is between one and one-half acres in extent, and is situated on Townsend Avenue, New Haven, only three or four miles from the center of the city. It was in grass in 1918, and was plowed in the spring of 1919 and planted to corn.

When only a few inches high, the plants began to look sickly and the outer leaves turned yellow, then shrivelled and died. The new leaves kept green for a time with the outer ones dead and brown, but the entire plant soon died.

At the base of each unthrifty plant a cavity or hole had been eaten into one side of the stem, often to its center. This injury was just at the surface of the ground or slightly above, and the grayish larva causing it was covered by a case formed of soil particles webbed together by silk threads, somewhat resembling small ant sheds. Apparently there was only one larva to each stalk, and when disturbed, the larva would quickly wriggle out of sight into crevices in the soil. Moreover the case or covering at first escaped notice because all of the plants were more or less spattered with dirt, and it was rather difficult to pull up a plant without losing the larva and its case.

On July 3, Mr. L. F. Harvey, county agricultural agent for New Haven County, first brought some of the injured plants to the Station laboratory.

Mr. M. P. Zappe, assistant entomologist, visited the field with Mr. Harvey the same afternoon and examined the plants and gathered more material. Later, on July 10, the writer visited the field. An occasional plant had escaped attack and was consequently much larger, darker green, and more vigorous than the other plants in the field. At that time there were many hills where all of the plants had been killed, and most of those remaining looked as if they would soon die. A few hills at the ends of the rows near the Avenue were not attacked and later I learned that these and occasional scattered stalks produced ears, probably less than a hundred all together, and the crop was almost a total failure.

At the time, this insect was supposed to be the corn web-worm *Crambus caliginosellus* Clem., a common species which injures corn in the middle and southern Atlantic states, and as all members of the force were busy with other work, no careful studies were made.

From the material gathered there emerged about September 1, four adults, which have since been identified at the Bureau of Entomology

as *Crambus præfectellus* Zinck., a native species which has not heretofore been recorded as injuring corn, though Mr. George G. Ainslie of the Bureau of Entomology, Cereal and Forage Crop Insect Investigations, stationed at Knoxville, Tenn., who has studied this and allied Pyralids, informs me that he has records of *præfectellus* being taken on corn in Florida, Arkansas and Tennessee, and on wheat in Indiana, but in no case was the injury of any extent or of any real importance. Prof. C. H. Fernald in *The Crambidæ of North America*, published in 1896, states that the early stages and food plants are unknown.

Mr. Ainslie states that there are few references in literature to this species, and most of them are systematic rather than economic. Apparently this is one of the first instances, perhaps the first, of any serious injury caused by this insect.

The larva is about 12 mm. long, 2.5 mm. thick, dirty white to ash-gray in color, rather prominently marked with darker tubercles. Each abdominal segment bears eight tubercles: six in a transverse row near the anterior margin of the segments, the outer two being below the spiracles; two transversely elongated ones, just back of the middle two, but more widely separated. Prothoracic shield whitish and shining, marked with several small dark gray spots; anal shield peppered with dark gray spots. Head whitish, shining, mottled dorsally with brown. Legs, prolegs and ventral surface, whitish. Each tubercle bears one or more hairs.

The adult is a Pyralid moth having a wing-expanse of from 20 to 24 mm.; forewings brown with a longitudinal white band extending from the base but narrowing to a point before reaching the subterminal. There is also a darker brown dash extending from the subterminal to the apex, and nearly bisecting the apical angle of the forewing, formed by white markings on each side. Terminal a darker brown line. There is a narrow, wavy, subterminal transverse line of darker brown whitish margined distally; between this line and the margin is a row of five small black elongated dots or short dashes. Fringe is light brown. Rear wings white, sometimes with a brownish tinge. Legs and antennæ light brown.

Adjournment.

Morning Session, Friday, January 2, 1920, at 10.00 a. m.

VICE-PRESIDENT A. G. RUGGLES: You will please come to order. The first paper will be presented on the "Work of *Empoasca mali* on Potato Foliage," by P. J. Parrott and R. D. Olmstead.

THE WORK OF EMPOASCA MALI ON POTATO FOLIAGE

By P. J. Parrott and R. D. Olmstead

Summary

This paper presented details of nine cage experiments and one field experiment to determine the effects of attacks of *Empoasca mali* LeBaron on potato foliage.

In all the experiments, feeding by the insects produced at first small brownish areas of one quarter of an inch or more in width at the tips and occasionally on the margins of the leaflets. The injury became more conspicuous as the season advanced, the brownish or burned areas increasing both in extent and numbers. The discoloration progressed from the tip towards the base of the leaf, and from the margins towards the midrib. As the tissues became desiccated the margins rolled up over the upper surface, leaving a small narrow strip of green tissue in the central area of the leaflet. In instances where such injuries were severe, all the leaflets curled and completely dried up, while the petioles often withered and dried so that any slight disturbance produced defoliation.

In the field test the planting comprised forty-two rows that were one hundred and eighty feet in length. • The variety of potato grown was Enormous No. 9. The purpose of this experiment was to determine the repellent effects of the usual spraying mixtures upon leafhoppers as compared with mixtures of heavier consistency. Applications were made of the following preparations: (1), bordeaux mixture (10–10–100); (2), bordeaux mixture (10–10–100) with 6 pounds of paste lead arsenate; (3), china clay, 60 pounds to 100 gallons of water to which were added 10 pounds of soap; and (4), bordeaux mixture (8–8–100) with 60 pounds of lump lime. Four rows or more were sprayed with each mixture and two rows were reserved as checks. The applications were made with a power sprayer at a pressure of 100 to 150 pounds, and great care was exercised to cover thoroughly each plant, especially the under sides of the leaves. The first treatment was made on July 8. As rains had washed to a considerable extent the spraying materials from the foliage and the leafhoppers were invading the treated plats, a second application was made on July 16. Heavy rains occurred again within the next ten days, which necessitated a third treatment on July 28. The last application was made on August 25, which later developments indicated should have been made earlier and followed with another treatment two weeks later. Counts were made of adult leafhoppers at more or less regular intervals, which showed plainly that all the spraying mixtures had exerted considerable influence as repellents. Moreover, at no time during the season were the nymphs

abundant on the sprayed rows. Nevertheless, nymphs were observed on the vines, and during the latter part of August occasional burned tips were found on the sprayed plants, which was attributed to the unavoidable postponement of the fourth spraying. The marked feature of the test was that the check plants showed during August burned tips and margins of the leaflets, while in early September they rapidly declined. At this time the sprayed vines presented in the main luxuriant foliage with only slight traces of injury; while the checks, in striking contrast to them, were inferior in size and had scanty foliage, which was to a large extent badly shriveled and brownish in appearance. It should also be noted that several experts in plant diseases, who had followed with interest the various developments in this experiment, pronounced the injury to the checks as undistinguishable from the disease known as tip-burn.

The heavy washes, composed of china clay or lime, were a little more effective in repelling the insects than the other spraying mixtures. These sprays, in spite of their heavy consistency, caused very little trouble in clogging the nozzles, and produced a thick coating of the foliage. However, some objectionable features developed which should be noted. The china clay was more easily removed from the foliage by rains than any of the other mixtures, in spite of the fact that it was combined with soap, while lime caused injuries to the foliage. The damage was first noted on July 29 when the third application was made, and after this date the injury considerably increased. Because of the serious damage, the heavy limewash was the least satisfactory of the various mixtures that were tested. Although the bordeaux mixture alone or in combination with lead did not prove as effective a repellent as the sprays of heavier consistency, it should be emphasized that thorough spraying of all surfaces of the leaves of potato plants prevented serious damage by leafhoppers. Furthermore, this spray withstood the washing effects of the rains much better than china clay or lime, the combination with lead proving somewhat superior to bordeaux mixture alone.

Mr. E. G. Kelly: In regard to Bordeaux-lime, do you make your Bordeaux and then add an excess of lime to it?

Mr. P. J. Parrott: Yes.

Mr. E. G. Kelly: What is the effect on the Bordeaux?

Mr. P. J. Parrott: I am not able to answer your question, as we have not submitted samples of this combination to our chemists for analysis. In this particular planting we did not suffer from late blight, but I do not recommend the addition of large amounts of lime

for the spraying of potatoes, because of the danger of injury to the plants. However, with both apples and pears large amounts of lime may be applied with little fear of injury.

MR. LEROY CHILDS: In my experimental work I found sulphur dust could be used for control. I am wondering if any work with dust has been carried on.

MR. P. J. PARROTT: No.

MR. LEONARD HASEMAN: This work on potato leafhopper bears directly on one of our projects. I would like to ask Mr. Parrott whether in his opinion the burning is due to the sucking of sap or to the possible introduction of poison?

MR. P. J. PARROTT: My opinion is that with plant lice and insects of that character there is not only injury as a result of the extraction of the juices of the plant, but I think there is something in the salivary secretions of the insects which is toxic to plant tissues and thus accentuates the injury.

MR. E. D. BALL: I would like to raise one further question. We have a large number of sucking insects occurring on a large number of plants. It does not seem to make any difference what plant the potato leafhopper feeds on, whether a potato plant, a Dahlia, a box-elder, an apple tree or a raspberry bush, it always causes this burning. We have leafhoppers on practically every one of those plants, and none of them produce anything of the kind. The burning is limited to a specific insect. Further than that, the explanation is very largely yet to come.

VICE-PRESIDENT A. G. RUGGLES: The next paper is "The Strawberry Root Worm Injuring Roses in Greenhouses," by C. A. Weigel and E. L. Chambers.

THE STRAWBERRY ROOT-WORM INJURING ROSES IN GREENHOUSES

By C. A. WEIGEL and E. L. CHAMBERS

The immediate circumstances leading up to this investigation were the simultaneous reports received by the Bureau of Entomology concerning two widely separated infestations of an insect injuring roses in greenhouses at Alexandria, Virginia, and Richmond, Indiana. The specimens which accompanied these reports upon examination were found to be a chrysomelid beetle, the strawberry root-worm, *Paria canellus* Fab.[1] This pest though frequently reported as a serious enemy of strawberries, has hitherto not been reported as injurious to

[1] Fabricius, J. E., 1801, Syst. Eleut., p. 52, Vol. 2.

roses grown in greenhouses. It has, however, been recorded by Forbes[1] as being abundant on Juniper, *Juniperus communis*, and on the wild crab apple, *Pyrus coronaria*, as well as on the strawberry. It occurs less commonly on a considerable variety of plants both cultivated and wild.

A visit to the Alexandria infestation on July 25, 1919, revealed the seriousness of the report and appeal for assistance. It was found that the damage was being caused mainly by the adults, which were present in extremely large numbers. A total of eight large houses suffered infestation, five of the open range type being extremely heavily infested. Practically all of the foliage was badly perforated and ragged, presenting a shot-hole appearance as a result of the voracious feeding. The more or less rounded holes, varying in size and shape, were so close together that the plants looked as though loads of shot had been fired into the foliage at short range. In addition, a large proportion of the new and young shoots had the wood badly scarred and girdled, giving it a very unsightly appearance. It was found that the adults had a marked preference for this new wood, of which there was an abundance at this particular part of the season, owing to the fact that the roses were being forced. Further examination showed that the larvæ had also been feeding on the roots earlier in the season. As a result of all of these injuries a gradual killing of the affected parts ensued, causing a stunted growth of the plants.

The Indiana infestation was investigated by Mr. Harry F. Dietz, who at that time was still with the Bureau of Entomology and incidentally was in that vicinity. From his report it was obvious that the infestation was not as serious as that at Alexandria. In this particular case the injuries were confined for the most part to a ground bed of Killarney's growing in one of the five open range houses in which the insects occurred. These plants which had been forcing for about three weeks had put forth an abundance of young tender shoots. This was an analagous condition to that which existed at Alexandria. On authority of the florist it was learned that serious injury had been experienced during the month of May from this pest.

In an attempt at that time to control it they sprayed their roses several times with a mixture consisting of two pounds of powdered arsenate of lead and twelve teaspoonsful of paris green added to fifty gallons of water. This mixture, however, did not stick well and proved ineffective. A commercial brand of kerosene emulsion, diluted one part to sixteen parts of water was also tried. While it was found to kill the adults, it caused serious burning of the plants, the injury being still visible at the time of Mr. Dietz's visit five weeks later. Nico-

[1] Forbes, S. A., 1883, 12th Rept. of State Ent., Ill., pp. 150–177.

fume liquid at the rate of thirty-six teaspoonsful to four gallons of water was applied and found only to stupefy, but not to kill the adults.

On further inquiries at the Indiana State Entomologist's office we were informed that the strawberry root-worm was first recorded as a greenhouse pest in that state, November 8, 1916. The specimens of the insect and the report of the injury came from a florist at Cumberland. The Richmond infestation evidently started in 1915, according to the following information:

It was ascertained from the Richmond florist that this insect probably found its way into his greenhouses, three years before, in the larval stage in sod which was brought into the houses at that time. This sod was taken from soil in close proximity to their establishment on which large patches of wild strawberry plants were growing. These wild strawberry plants are also abundant at present on the right-of-way of the Pennsylvania railroad which runs directly by their infested houses.

A subsequent report indicated that it has been found attacking garden grown roses in the same vicinity.

In attempting to establish the possible origin of the infestation in Alexandria, records show that Mr. A. D. Borden had reported this insect as attacking roses in these same houses three years before. Recent evidence discloses that the soil in which the roses are now growing has been in these benches since then. We are, therefore, led to believe that the present occurrence dates back to that time.

Early in November the writers collected specimens of the strawberry root-worm in the rose house of the United States Botanical Garden at Washington, D. C., where they were doing serious injury. Since then, reports of its occurrence on roses have been received from Summit, N. J. In addition to this, E. N. Cory[1] in 1916, of Maryland Experiment Station, had occasion to work with it on roses in a florist's establishment at Baltimore.

A circular letter sent to all State Entomologists as well as other entomological workers has thus far failed to give us further records of its occurrence on roses, except the one record from Summit, N. J. This information was received from Dr. Peterson, the Assistant State Entomologist, substantiated by a report from the florist whose roses were infested.

Further information gathered from replies received indicates that it has been known to injure mountain ash, crab apple, and occasionally is reported as doing considerable damage in apple orchards. While primarily a pest of strawberries, its injuries to the above hosts are only occasionally of great consequence.

[1] Cory, E. N., 1916, Md. Agr. Soc. Rept., 1 p. 206.

History and Habits

The strawberry root-worm was first described by Fabricius[1] in 1801, under the name of *Cryptocephalus canellus* from a specimen in the collection of D. Bosc, recorded as collected in Carolina. Subsequently, and in recent economic accounts, this pest is commonly referred to under the name of *Typophorus canellus* Fab. According to Blatchley's classification, "to this genus belongs the species listed by Henshaw under the name of Paria." It appears as "Paria canellus Fab." in "Coleopterorum Catalogus" p. 156 by H. Clavareau (1914). The species is very variable in its coloration and many varieties are listed.

From the observation made at Alexandria, Va., as well as those from Richmond, Ind., it appears that this pest is single brooded, unless possibly an early generation may occur during the spring months of the year. At the time of our first visit (July 25, 1919) a copious number of adults were present, although several larvæ and pupæ were still to be found in the soil.

The florist in charge of the Richmond houses has observed the following habits: "In the spring throughout the first part of April the adults reappeared and about the middle of May and the first part of June do noticeable injury to the leaves."

Unfortunately, the authors were unable to make observations prior to the time at which it was called to their attention except as to injury displayed on the roots. The adults are rarely seen and have never been observed feeding during the brighter hours of the day. Occasionally they may be collected in dead or dried and curled up leaves or under débris, etc., among the surface soil. Beginning at dusk and extending to the early morning hours they may readily be observed feeding on the plants. On being disturbed they play possum or feign death.

Observations at the Alexandria houses on the varieties most seriously attacked showed the beetles displayed a fondness for the Sunburst, Red Radiance, Killarney and Ophelia, of which the first named suffered most severely. At Richmond, the Premier and Ophelia seemed to be most heavily injured, with the Columbia, Victor, Hoosier Beauty and Killarney in the order named.

Experiments on Control

Inasmuch as a serious infestation existed in the above-named greenhouses, the entire crop of roses was threatened, because the ravages of the insects were progressing at such an alarming rate. Moreover, roses at this season of the year were being forced as the weather conditions were very favorable. Therefore a delicate situation presented

[1] Loc. cit.

itself, and necessarily the program of control would have to be in accordance with the cultural methods, so as not to prove deleterious to the future growth of the plants.

Ordinarily arsenicals are the standard remedies used to combat such ravenous leaf feeders. Hence, it was decided to make a few preliminary tests of varying strengths of paris green, calcium arsenate, and arsenate of lead. It was found that powdered arsenate of lead did not injure the roses when used at the rate of two to two and a half pounds to fifty gallons of water, adding one-half ounce of soap to each gallon of spray material. All of the infested plants were, therefore, thoroughly sprayed with the above insecticide, using a pressure sprayer. Special care was taken to cover all the foliage so that it presented a white-washed appearance which was retained for many days. Contrary to the general reported control on strawberries with arsenicals, it was soon found, however, that under the existing conditions such measures were ineffective. This was due to the particular choice which the adults showed for the young and tender growth that was being forced, during the hot sultry nights, and which in turn could not be sprayed constantly in order to keep it covered with arsenate of lead. This was coupled with the insects' nocturnal feeding habit. Further, it was found that they practically avoided the lead covered foliage. This naturally necessitated an immediate change of the control program because of the alarming rate at which the injury was proceeding.

The next consideration, therefore, was the use of a standard fumigant such as hydrocyanic-acid gas which is frequently employed in greenhouse fumigation. Here again, we were confronted by the question of determining a killing dosage for the adult beetles, of which very little was known. Secondly, the advisability of using such measures on the tender growth.

Preliminary experiments with a fourth to half an ounce of sodium cyanide per thousand cubic feet of space proved entirely ineffective. The maximum dosage which roses are known to withstand, using two ounces per thousand cubic feet of space was therefore employed. The exposure lasted two hours. It is advisable to point out the fact that fumigation at this strength and duration during hot sultry summer nights is contrary to the general recommendations for fumigating greenhouses, but drastic measures were imperative, otherwise the whole crop might just as well have been left to the insects for complete destruction which most certainly would have followed.

An examination of the fumigated houses at 8:30 o'clock the following morning showed very encouraging results. The beetles were found lying on their backs, or sides, exposed on the surfaces of the foliage in great numbers. Many were killed in their tracks in the act of feeding,

while others could be found lying on the surface of the bench soil and beneath the plants. Owing to the fact that the adults showed a marked tendency to feign death, a total of 317 of the apparently dead insects were collected and held in cages for several days for further observations. Of these less than 3 per cent revived from the effects of the gas, or expressed in other words a killing of 97 per cent of the adult beetles resulted from the above fumigation.

As was anticipated practically all of the tender growth was more or less burned. This injury, however, was only temporary since at the expiration of three weeks the plants were in excellent condition and had produced an abundance of newly forced growth which was attributed to the stimulating effects generally following fumigation with hydrocyanic-acid gas. Incidentally the burning back of this young growth deprived the few remaining adults of their favorite place of feeding.

From the above experiments it appears that until further progress has been made in life history studies and habits of this new rose pest in greenhouses, a satisfactory method of controlling the adults of the strawberry root-worm is by the use of hydrocyanic-acid gas, at the rate of two ounces sodium cyanid per one thousand cubic feet of space, with an exposure of two hours. The destruction of the adults at this time should forestall a recurrence the following spring and summer, since a very large percentage of the adult females are killed many months prior to the normal time of egg laying.

Mr. Alvah Peterson: This insect has been very injurious in a large rose-house at Summit, N. J., for three seasons. For two seasons we have been making more or less careful studies on the life history and control measure. We have found at least two generations during the year, the adults appearing in large numbers during the months of June and July, and again in September. At this time of the year (December) you will find the form in the soil passing the winter in the adult stage. About the first of February, the adults come out, feed and then deposit their eggs. They continue to deposit eggs until about the last of April, and a little later young larvæ are found in the ground about the base of the rose plants. Full grown larvæ and pupæ are abundant early in June. The adults make their appearance in considerable numbers in June and July. During August the adults are greatly reduced in numbers. Again in September full grown larvæ and pupæ may be found in the soil and the pupæ change into adults. So far as observed all of the adults come out and feed before going into a dormant condition.

In respect to control measures, we have tried soil treatments, fumigations and sprays. As yet, we are not satisfied with any of the results. Hydrocyanic acid gas was used in August at the rate of one and one-half ounces for twenty minutes. A very serious burning of the foliage and young growth occurred and only a small per cent of the adults were killed. The burned plants were set back to such an extent that they did not fully recover that season. Dusting with a lead, sulfur and lime mixture when the plants are in the drought period (June and July) gives considerable promise for control.

At the present time, Mr. May, who is the owner of this greenhouse, employs a beating method. When the adults are abundant in the morning, he puts his force to work beating the bushes. The men hold pans under the bushes and catch the adults as they fall. When the bushes are jarred, the adults will fall from them. This seems to be a very crude and an expensive method. The adults have been caught in large numbers and the infestation has been reduced to such an extent that this past season the injury produced by the adults was by no means as serious as in previous seasons.

President W. C. O'Kane: The next paper on the program is "Poison Baits for Grasshoppers," by W. P. Flint.

POISON BAITS FOR GRASSHOPPERS

By W. P Flint, *Urbana, Ill.*

Under Illinois conditions at least 75 per cent of the damage by grasshoppers occurs in fields of clover, alfalfa, soy beans, cowpeas, and other legumes. This is not due so much to the fact that the hoppers hatch from eggs deposited in such fields as that they congregate in them during the summer. It would seem that under our conditions legumes are distinctly attractive to grasshoppers and it was thought that a poison bait with a strong legume odor might possibly prove more attractive than the standard bran-molasses-lemons bait. So far as known to the writer, no tests with such mixtures have been made, with the exception of the alfalfa meal mixture which has been used to some extent in the west and very little in the states east of the Mississippi. The odor from the alfalfa meal, however, differs from that of freshly ground legumes, and has not been found particularly attractive to grasshoppers. To test the effect of adding freshly ground legumes a series of experiments was carried out, using the standard bran bait in comparison with a bran-Paris green bait containing the same amount of poison, but in which a certain amount of freshly ground legumes had been mixed.

The inner bark of the black locust, *Robinia pseudacacia*, has the strongest characteristic legume odor to be found in any plant known to

the writer. For this reason it was selected as the substance to be used in the first test with these baits. Of course, this bark could not be obtained in sufficient quantities to make practical its general use for this purpose. Twenty-five pounds of bran and one pound of Paris green were mixed dry, and a stiff mash was made by adding water in which had been stirred about one-half pound of the ground inner bark of the black locust. The generally recommended bait, consisting of 25 pounds bran, one pound Paris green, two quarts molasses, six lemons and water sufficient to make a stiff mash, was mixed at the same time, and the two baits applied at the rate of about 10 pounds to the acre in a clover field where the hoppers averaged about 25 per square yard. The baits were sown early in the morning, and counts of the dead hoppers in five square yards made in the afternoon of the next day. The results of the test with this material showed nearly as many grasshoppers killed where the legume was used instead of the molasses and lemons. As the locust bark was difficult to obtain and also hard to grind, three pounds of freshly ground green beans were substituted in subsequent tests.

During 1918 and 1919 seven tests were made, using the standard bran mash, and in comparison, the same amount of bran and Paris green mixed with water containing three pounds of finely ground green beans. In all but one of these tests a considerably higher number of grasshoppers were killed where the beans were used, as was shown by counts of the dead hoppers found by carefully examining five square yards of the treated clover fields the second afternoon after the baits had been sown. Counts made in this manner in 45 square yards of treated clover showed an average of two dead hoppers per square yard more in the areas treated with green beans than in those where the standard poison bran bait had been used. This is not a very much higher kill, but seems to prove rather conclusively that this bait is at least as good as the standard mixture. With the present price of materials for making these baits, it will cost about 25 cents per acre less to treat with the legume bait than with the molasses and lemons. This bait has the added advantage that the materials for making it are nearly always at hand.

During the summer of 1919 several experiments were tried in which three pounds of freshly ground clover were substituted for the ground green beans. The results of these tests showed that the bait made in this manner was practically as good as that made with the beans, and was a little better than the bran-molasses-lemons bait. Recent work of Dr. Morrill in Arizona[1] seems to show that the bran bait without the addition of either molasses or lemons is nearly, or quite, as effective as

[1] Jour. of Econ. Ent., Vol. 12, p. 337.

the bait where these materials are used, and it is possible that the use of legumes has not added very greatly to the attractiveness of the bait in the experiments just reported. However, no work was done which would give a comparison with bran, Paris green and water alone. The eight tests reported seem to show conclusively that the addition of the ground legumes to the water used in mixing the bran and Paris green bait renders it fully as attractive as does the addition of molasses and ground fruits, in the quantities usually recommended.

The following table shows the number of dead grasshoppers found in five square yards, on examining the fields where the different baits had been applied.

There are certain situations in which it is not desirable to use the poison bran baits. Some of these are roadsides, ditch banks, and like places, covered with a growth of large tall weeds; gardens and truck patches in the vicinity of dwelling houses, where the owner may not wish to use the bran bait for fear of killing chickens or wild birds; although there seems to be very little, if any, evidence to show that birds are ever poisoned by this mixture. Several years ago the writer noticed the fact that grasshoppers feed readily upon paper, especially the heavy brown wrapping paper such as is generally used in stores for wrapping heavy parcels. It seemed that it might be possible to treat papers with a poisonous solution to which some substance attractive to grasshoppers had been added, and that such papers if fed upon by the hoppers would prove effective in killing them. It was thought at first that the soluble poisons would be best to use in this way, and that papers soaked in such solutions would probably absorb sufficient poison to render them effective in killing the grasshoppers should they feed upon them. A few tests with papers soaked in solutions of one gallon of molasses, two pounds of sodium arsenite and 32 gallons of water failed to kill any grasshoppers, although the insects fed upon the papers in large numbers, and continued to feed upon them for several days. A solution was made in the same proportions, but substituting for sodium arsenite, crude arsenic containing about 10 per cent water soluble arsenic. A few grasshoppers were killed by feeding on papers soaked in this solution, although this was not nearly as effective as the standard poison bran mash. As the grasshoppers fed readily upon the papers, and still but poor results were obtained as far as actual number killed was concerned, it was thought possible that an insoluble poison would increase the effectiveness of this method of treatment. Consequently an experiment was tried using Paris green in place of the more highly water soluble poisons. In these experiments several old newspapers were torn into pieces about four inches square, and soaked for one-half hour in a mixture of one gallon water, one-fourth cup molasses,

TABLE I. NUMBER OF DEAD GRASSHOPPERS FOUND IN FIVE SQUARE YARDS

SPRINGFIELD, 1918

	25 lb bran, 1 lb Paris green, 2 qt molasses, 6 lemons, water	25 lb bran, 1 lb Paris green, 6 lemons, water	25 lb bran, 1 lb Paris green, 2 qt molasses, water	20 lb bran, 1 lb calcium arsenate, 2 qt molasses, 6 lemons, water	25 lb bran, 1 lb Paris green, 3 lb ground green beans, water
Sown July 17, Counted July 18	106	89		76	94*
Sown July 30, Counted Aug 1	152		139		171
Sown Aug 1, Counted Aug 3	129		75		165

URBANA, 1919

	25 lb bran, 1 lb Paris green, 3 lb ground green cornstalk, water	25 lb bran, 1 lb Paris green, 3 lb ground clover, water	25 lb bran, 1 lb Paris green, 3 lb ground green beans, water	25 lb bran, 1 lb Paris green, 2 qt molasses, 6 lemons, water	25 lb bran, 1 lb crude arsenic, 2 qt molasses, 6 lemons, water
Sown July 18, Clover Stubble, Counted July 19			32	9	10
Sown July 23, Counted July 25	25		25	19	10
Sown July 25, 6" Clover, Counted July 26	21		48	41	32
Sown July 28, Hard Rain, Counted July 30	1	29	11 (Mash Sour)	27	20
Sown Aug 2, Counted Aug. 4	21	29	34	26	17
Sown Aug. 6, Counted Aug. 7		135		151	

*Ground inner bark of black locust was used instead of ground green beans

two ounces Paris green and one ounce salt. These papers were sown between 5:00 and 6:00 a. m. over a clover field containing about 25 grasshoppers to the square yard. An adjoining strip in the same field was treated with the standard poison bran mash at the rate of about 10 pounds per acre. The papers were sown as evenly as possible over the field in such a manner as to leave the bits of paper about six inches apart. Counts made the second day from the time of application showed nearly four times as many dead hoppers per square yard in the area where the papers had been used as in that sown with the poison bran mash. At this time grasshoppers were still feeding in considerable numbers upon the papers, although they fed very little upon the poison bran except during the first few hours after it was applied. In fact, several later visits to this field showed that the hoppers continued to feed upon the poisoned papers until they were almost entirely consumed. The results of two other tests conducted in the same manner showed a much higher number of grasshoppers killed in parts of the field where the poisoned papers were scattered than in that treated with the poison bran mash.

While sufficient tests have not been carried out to prove that greater numbers of grasshoppers can be killed by the use of poisoned papers than with the poison bran bait, it seems advisable to mention this method, as it has several distinct advantages. If later experimental work proves that such a method is more, or equally, effective, the preparation of such papers might be taken up by some of the insecticide companies. It seems that such a paper could be manufactured, containing the poison and some substance rendering it attractive to the grasshoppers, and could be sold in bulk. To prepare it for use one would merely have to soak this paper in water and distribute it on the infested fields. Such a material could probably be sold much cheaper than the homemade poison bran mash could be prepared, and if distributed through the usual trade channels, would be used more readily by the average farmer than is the case where he has to mix the materials himself.

Mr. Stewart Lockwood: I would like to ask if any count was kept of the grasshoppers feeding on the poisoned paper when it was damp and when it was dry. Did they eat more of the damp paper than of the dry paper?

Mr. W. P. Flint: The papers seem to work in much the same manner as the bran. When the paper was distributed it was damp and the grasshoppers came to it from quite a distance, although quite a few were found feeding on the paper in mid-afternoon of a bright day when it was thoroughly dried up.

MR. T. J. HEADLEE: Is there danger of cows, chickens, etc., eating poisoned paper?

MR. W. P. FLINT: I do not know that there is any greater danger in using the paper than in using poisoned bran. I was, however, able to overcome the prejudice with some people by using paper instead of bran.

MR. J. R. PARKER: At the Montana Experiment Station this past summer we conducted preliminary experiments with twelve different attractive substances and much to our surprise found that lemons and lemon extract ranked at the bottom of the list and that amyl acetate was far ahead of any of the others; we also found that salt alone was practically as good as when both molasses and fruit juices were used.

MR. ARTHUR GIBSON: In our work in Eastern Canada, we have conducted a large number of experiments in controlling locusts and like Mr. Parker, we have found that salt is one of the best attractants. We used the ordinary Kansas bait in 1915 at the cost of 21 cents an acre. Substituting salt for the molasses and fruits we reduced the cost to 7 cents an acre. One of the best formulas we used was 20 pounds of sawdust, one-half pound Paris green, one-fourth pound salt, and three gallons of water. We have killed, with this mixture, up to 720 locusts to the square yard.

PRESIDENT W. C. O'KANE: The next paper is entitled "Organization for Grasshopper Control," by George A. Dean and E. G. Kelly.

ORGANIZATION FOR GRASSHOPPER CONTROL

By GEORGE A DEAN, *Entomologist, Kansas State Agricultural College and Experiment Station*

and

E. G. KELLY, *Extension Entomologist, Kansas State Agricultural College*[1]

Since the first recorded devastation in Kansas, western Kansas has been the scene of several outbreaks of grasshoppers. Inasmuch, however, as several other western and some eastern states have records of devastation by this pest, Kansas cannot claim the distinction of being the "Grasshopper State," although it has been so dubbed by many people. The state has a large acreage of level prairie lands suitable for cultivation and in proportion to its area probably has almost as large an acreage under cultivation as any other state. In spite of the fact that there is very little waste land on farms, the roadsides and fence-rows afford abundant breeding grounds for grasshoppers. Western Kansas grows a large acreage of wheat, oats, barley, alfalfa, corn

[1] Contribution No. 50, from the Entomological Laboratory, Kansas State Agricultural College.

and sorghum, and at one season or another these crops are all subject to attack. Wheat is often attacked in the fall, the hoppers coming in from the edges and roadsides, and devastating a strip of the young wheat from two to four rods wide. In cases of bad outbreaks, such as the one in the fall of 1918, entire fields are devastated by the lesser migratory grasshopper, *Melanoplus atlanis*. In the summer oats, barley, alfalfa and corn are frequently damaged by the hoppers concentrating soon after leaving the ripened wheat. Sorghum, except when very small, is not readily attacked.

In the fall of 1918, thousands of acres of fall sown wheat were devastated by the grasshoppers and millions of eggs were deposited in the favorite places, especially in wheat planted on fallow land and in corn land. Many miles of roadside and fence-rows were burned and disked, destroying myriads of eggs, and had all the farmers practiced this method of control there probably would have been no serious infestation in 1919. The several miles of disked roadsides and fence-rows amounted to a small percentage compared to the thousands of miles not disked. Early in May the grasshopper eggs began to hatch, and by June 1 the roadsides and fence-rows were literally swarming with young hoppers. A general warning was sent out calling attention to the seriousness of the situation, and a few farmers who realized the danger put out the poisoned bran mash. Three counties even organized for concerted action, but still the farmers went about the work with an indifferent attitude, believing the hoppers would do no damage to the wheat or other crops.

In early June farmers were surprised to find so many hoppers scattered over the wheat fields, instead of along the edges only as in previous years. Investigation soon showed that the fields in which the hoppers were so plentiful were either fallowed or fields following corn. Since these fields were in good condition of tilth they were not even so much as disked or harrowed before planting, and thus the hoppers found a hard surface in which to deposit their eggs. It was in these fields that they were found in early June and not in those which had been recently cultivated before seeding. It was also these fields that later suffered devastation. Although the grasshoppers were in the wheat, oats, and barley in much larger numbers than the farmers expected, yet they had always had grasshoppers in these crops and had managed to harvest a crop. This year, however, the hoppers won out. The hot days in late June following a wet period ripened the wheat very rapidly. The hoppers had eaten most of the leaves and those left dried quickly in the hot sun. The grasshoppers in search of food simply crawled up the stalks where they found a bit of green just below the head. Here they ate an elongated notch into the stem. Right at

this time there came an unusually hot Saturday, followed by a brisk wind on Sunday, and when the sun set on that memorable day, June 29, Kansas had lost millions of bushels of wheat which was literally strewn on the ground. The wheat fields had the appearance of having been cut with a dull header. There were several counties in Kansas and Oklahoma injured in this manner. An official estimate of loss in one county (Ford County) was one and one-half million bushels of grain, or more than three million dollars. Since the sudden ripening of wheat precipitated the hoppers into the oats and barley which were still green, another big loss was caused, and corn, alfalfa and sorghum were threatened. In the stricken counties the situation was recognized as alarming, and a hurry-up call for assistance came to the college. On July 15 a special conference of county agents was called at Dodge City. Twelve county agents from Kansas and two from Oklahoma met with Karl Knaus, County Agent Leader, and E. G. Kelly, Extension Entomologist, for the purpose of drawing up plans for immediate action. The Kansas grasshopper law[1] made it possible for very quick action. According to the law, upon receiving "a written request signed by not less than five township trustees of any county, or by a majority of the township trustees in counties having less than five townships in this state, the board of commissioners of that county shall provide for the purchase of a mixture containing Paris green, or other like poison, for the extermination of grasshoppers within its county, and shall make rules and regulations for the distribution and use thereof, and shall distribute the ingredients of such mixture to the township trustees of the various townships which may require the use of such mixture for the extermination of grasshoppers in their respective townships. In purchasing and preparing the ingredients of such mixture, the board of county commissioners and trustees of such township shall use the formula prescribed and recommended by the Kansas State Agricultural College or its experimental stations as far as practicable."

There were 28 counties in Kansas, and four in Oklahoma in which immediate action was to be taken. The arsenic, lemons, syrup and bran needed were estimated. Telegrams went out to dealers for information on supplies and quotations. By 6 p. m., July 16, the supplies were located and quotations furnished. A carload of white arsenic en route to a Kansas City commission firm from Utah was rerouted for Dodge City at Denver, Colorado. This was indeed fortunate for arsenic was the one article most needed and most difficult to procure. The other ingredients were closer at hand and readily accessible.

[1] Chapter 147, Session laws of 1917, as amended by House Bill No. 159, Session Laws of 1919.

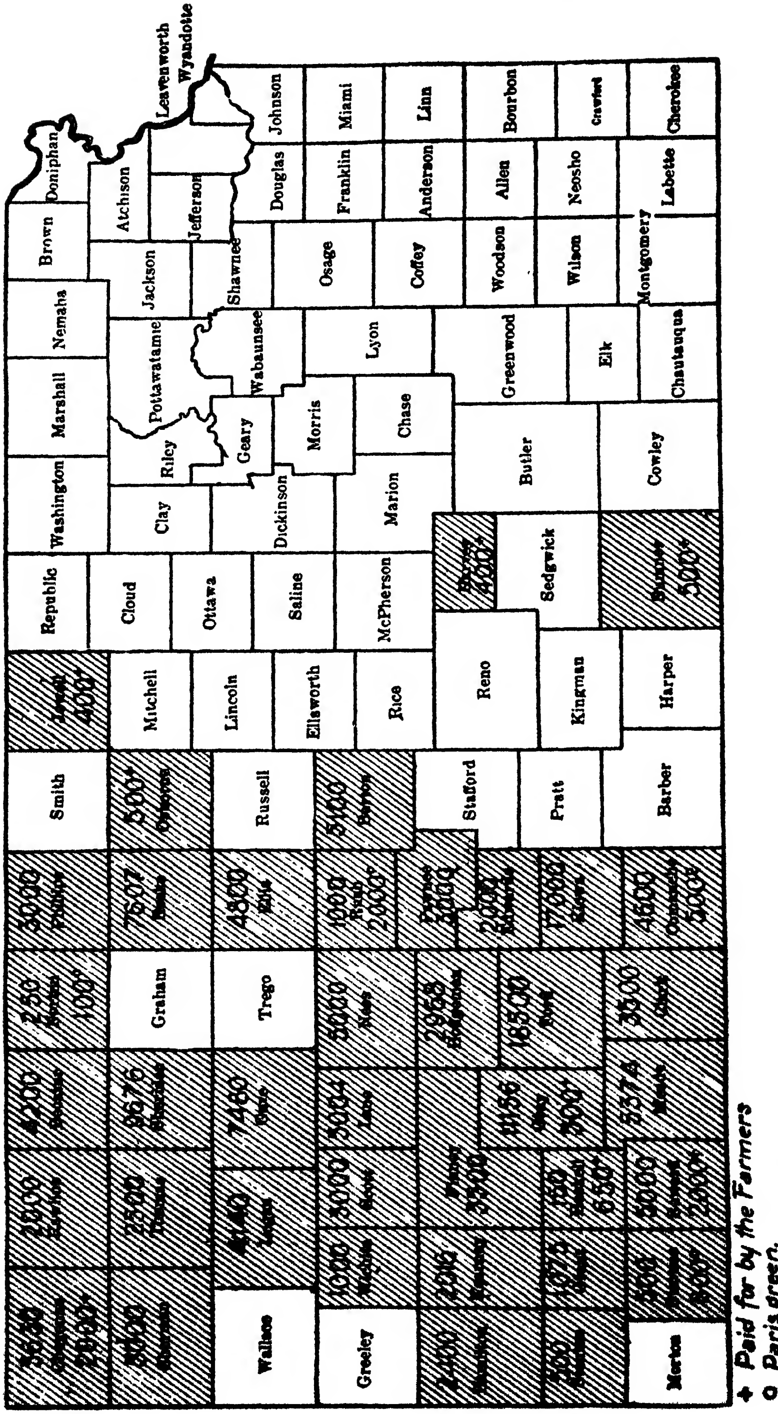


Fig. 6. Number of pounds of white arsenic or Paris green used in the grasshopper campaign of 1919. (Unless otherwise indicated, the poison was furnished by the county.)

The second and most important step was organizing the forces in each county for effective work. Each county agent readily handled his county through the farm bureau. The counties without county agents were organized by representatives of the college during the following eight days. The method of organizing the county was to have the township trustees request a meeting of the county commissioners at which time they not only presented the petition to the county commissioners, but also made an estimate of the amount of material their respective townships would need. The commissioners acted at once and placed an order for the material. The township trustees were responsible not only for the equitable distribution of the material for making the poisoned bran mash, but also for seeing that no one shirked his duty.

The northwest counties did not suffer loss to wheat but as soon as the wheat was cut the grasshoppers began migrating to corn, barley, alfalfa and sorghum. Ten of these counties coming under the jurisdiction of one district agent were organized by him with the assistance of two representatives from the college.

The coöperation of the farmers, county commissioners, and township trustees was such that many thousand acres of crops were saved from devastation and millions of grasshoppers killed.

The total number of counties organized was 39, representing an area of 33,985 square miles, or about two-fifths the entire area of the state. The total amount of bran mash distributed was 4,565 tons, or 183 carloads. This required 83 tons of white arsenic, 498,000 lemons, and 83,000 gallons of syrup.

In addition to the above amount of white arsenic, 20 tons more were ordered to be used in the fall in case the situation warranted it.

The results of the poisoning campaign were excellent throughout the infested areas. Very few reports of poor results were received, and in practically every case these were due to improper mixing and applying. It should also be borne in mind that poisoning the grasshoppers at this time also protected the fall wheat, for no reports of injury to this crop have reached the office this fall.

Mr. Stewart Lockwood: I would like to ask Mr. Dean to go a little more thoroughly into his organization of the county and township. When the material was received, how was it handled to get it out directly to the farmers?

Mr. G. A. Dean: For a number of years we have been using poison bran mash in Kansas, and thus a majority of the township trustees are thoroughly familiar with the method of distributing it. In many cases, when the county commissioners receive the materials, they

turn them over to the township trustees, who have previously estimated the amount they will need in their townships and who are held responsible for the work. The farmers come to their township trustees for their materials. In other cases, the farmers all come to the county seat where the materials are checked out by the commissioners, or the county farm agent. If the township trustee is not familiar with the proper method of preparing the poison bait and distributing it, either the county agent, or a person from the college will spend a day with him in order to demonstrate the proper method of mixing and distributing. As a matter of fact, since the bran mash has been used very extensively for several years, nearly all of the farmers are thoroughly acquainted with the work, and need no assistance except in organizing for concerted action.

Mr. Stewart Lockwood: It might be of some interest to know that in North Dakota we have put on a campaign along similar lines. We have been forced to use 6,600 tons of bran and about 540,000 pounds of arsenate with the ingredients to go with it. We haven't had time to experiment with different formulas, but we have taken the Kansas formula with the exception of adding four pounds of salt to the arsenic, and we have advised the farmers in every case to ferment their mixture, that is, to keep it in a barrel or sack that is damp twenty-four or forty-eight hours before it was spread. We will say that up there in North Dakota the poison bran mash that had been fermented gave much more satisfactory results than the other.

President W. C. O'Kane: Mr. J. W. McColloch will present the next paper, "A Study of the Oviposition of the Corn Earworm with Relation to Certain Phases of the Life Economy and Measures of Control."

A STUDY OF THE OVIPOSITION OF THE CORN EARWORM WITH RELATION TO CERTAIN PHASES OF THE LIFE ECONOMY AND MEASURES OF CONTROL[1]

By James W. McColloch, *Associate Entomologist, Agricultural Experiment Station, Kansas State Agricultural College*

In 1908 the Department of Entomology of the Kansas Agricultural Experiment Station undertook a complete study of the corn earworm (*Chloridea obsoleta* Fabr.) with relation to its injury to corn in Kansas. These studies had been in progress but a short time when it became apparent that a thorough investigation of oviposition in the field would furnish much valuable information relative to many points in the life

[1] Contribution No. 43 from the Entomological Laboratory, Kansas State Agricultural College. This paper embodies some of the results obtained in the prosecution of project No. 9 of the Agricultural Experiment Station.

cycle and towards the development of certain methods of control. Accordingly, during 1908 and 1909 general egg counts were made at irregular intervals in the field, and the results of these counts with relation to the number of broods and to the time of planting corn have been discussed by Headlee.[1] These preliminary studies were of such significance that in 1913 further experiments were planned to determine more accurately the relation existing between oviposition and various phases of the life history and methods of control.

These experiments were incorporated in "a time of planting experiment of corn" which has been in progress since 1909. Briefly, the major problems under consideration were to determine (1) the number of broods in the field, (2) the part of the corn plant selected for oviposition, (3) the relation of oviposition to the time of planting corn, and (4) the relation of oviposition to the variety of corn.

Experimental Methods

Time of Planting Experiment

In order to better understand the data presented in this paper, a brief discussion of the time of planting experiment is essential. This investigation has consisted of a series of five or six plots of corn planted at regular intervals beginning April 15. Four standard varieties of corn, namely, Boone County White, Commercial White, Kansas Sunflower, and Hildreth, have been grown in each plot, each variety being planted in three 200-feet rows. Plantings were made on April 15, May 1, May 15, June 1, and June 15. In 1914 and 1915 a sixth plot was planted on July 1, but since corn seeded at this time seldom if ever matures, this plot was discontinued. Since 1913 this experiment has been conducted on the same area and the land has been handled in the same manner as is usually followed by the average farmer. The rows were forty inches apart and the hills thirty-six inches. Shortly after coming up, the corn was thinned to two plants in a hill.

Method of Making Egg Counts

The egg counts were made on the same plants throughout the entire season. A typical plant of each variety in each plot was selected when it was about six inches high, and was examined daily for eggs of the corn earworm. These plants were selected through the center of the plots and were in the middle row of each variety.

Silking

As earlier studies at this station and in other localities had shown that the earworm moths apparently preferred the silks of corn and

[1] Headlee, T. J., Notes on the Corn Earworm. In Jour. of Econ. Ent., Vol. 3, No. 2, pp. 149–157, 4 charts. 1910.

corn plants that were in silk, it seemed advisable to follow the silking of the different varieties in each plot to determine the relation existing between silking and oviposition. Accordingly, in 1913, a detail study of silking was undertaken. The number of ears bearing fresh or attractive silks were counted each day on the middle row of each variety in each plot, a silk being considered attractive from the time it appeared until it became dry.

Climatic Data

Climatological conditions, especially rainfall, have a direct bearing on the growth of the corn plant and also to some extent on the corn earworm. In order to properly interpret the data presented in this paper, the essential records of rainfall are shown in Table I. It usually follows in the area under consideration that the various climatic conditions correspond to the rainfall. Periods of low rainfall during the growing season are generally associated with high temperatures and hot winds. Conversely an abundance of moisture usually means moderate temperatures and absence of hot winds.

TABLE I—SUMMARY OF THE RAINFALL (IN INCHES) AT MANHATTAN, KANSAS, FOR THE GROWING MONTHS OF 1913 TO 1918 INCLUSIVE

Year	April	May	June	July	August	September	Total	Total for the three summer months
1913	2.96	7.18	1.55	0.17	0.65	5.69	18.20	2.37
1914	1.19	2.33	4.58	2.40	3.56	5.76	19.82	10.54
1915	2.04	9.45	6.69	12.01	3.07	3.92	37.18	21.77
1916	2.17	6.40	7.43	1.92	0.76	8.12	26.80	10.11
1917	4.59	5.04	4.80	0.68	6.92	1.63	23.66	12.40
1918	3.74	4.89	1.33	2.26	3.71	2.31	18.21	7.30

The years 1913, 1916, and 1918, were exceptionally poor corn years, due to the extreme drouth of midsummer and the prevalence of hot winds. These conditions had a direct influence on the number of silks present on the plants and consequently on the location of the eggs. Conditions were somewhat better in 1914 and 1917 with the result that the growth and development of the plants was more nearly normal. The best year of the six that these investigations have been under way was 1915, when the midsummer rainfall was excessive and the temperature was moderate.

General Observation on the Oviposition of the Corn Earworm in the Field

Oviposition normally occurs at night, the adults being most active at this time. During the clear, hot days of midsummer, the moths usually begin flying and feeding about 5:30 p. m., and egg laying begins shortly after, continuing often until dawn. On cloudy days, or during the cool days of fall, oviposition may occur in the daytime. Until the corn crop is fully matured, eggs are rarely found on plants other

than corn, and a study of oviposition on corn is a study of the oviposition of the species.

A single female is capable of depositing from 500 to 2,000 eggs, and as high as 570 may be deposited in a single night. The eggs are laid singly, and generally only one or two on a plant. In ovipositing, the female lays from three to six eggs, then feeds for a short period before resuming oviposition, this process being repeated throughout the night.

Destruction of the Eggs by Natural Agencies

In the course of these studies, it was found that many natural agencies were responsible for the destruction of the eggs, or at least for their removal from the plant within a short time after deposition. The principal predaceous enemy of the egg was found to be the common flower-bug (*Triphleps insidiosus* Say) which often destroyed from 25 to 50 per cent within 24 hours after deposition. Other predaceous enemies were the larvæ and adults of the lady beetles *Hippodamia convergens* Guer., *H. 13-punctata* Linn., *H. parenthesis* Say, *H. glacilis* Fabr., *Adalia bipunctata* Linn., *Megilla fuscilabris* Muls., and *Cyclonida munda* Say. In addition, the larvæ of the lace wing (*Chrysopa* sp.) were often observed feeding on the eggs. A number of insects in feeding cut off many corn silks which bear eggs and these fall to the ground. Many eggs are also removed from the plants by winds and beating rains. Two parasites, *Trichogramma pretiosa* Riley and *Telenomus heliothidis* Ash., attack the eggs, but their presence had no influence on the egg count.

Presentation of Experimental Data

This study of oviposition and silking has been in progress for a period of six years, and during that time 128 plants representing four varieties of corn have been examined regularly for eggs of the corn earworm, and the same number of rows followed with regard to silking. The period represents one exceptionally bad earworm year (1914), two years of about normal conditions (1913 and 1918), and three years of light corn earworm injury (1915, 1916, and 1917). This period is also one presenting extremes of climatic conditions from excessive drouth and hot winds to high rainfall and moderate temperatures. The detail data obtained in these studies are summarized in Table II to show the total number of eggs found on each variety of each date of planting and in Table III is shown the location of the eggs with relation to the date of planting. The data secured from the plantings of July 1 in 1914 and 1915 are included in the discussion which follows wherever they are applicable. There are a number of instances, however, where these data are omitted, since they do not represent average conditions.

TABLE II—SUMMARY OF THE TOTAL NUMBER OF EGGS DEPOSITED ON EACH VARIETY OF EACH DATE OF PLANTING PLOT, MANHATTAN, KANS., 1913–1918

Variety	Planted		1913	1914	1915	1916	1917	1918	Total
Boone	April	15	6	2	2	1	1	17	29
County	May	1	4	6	4	0	2	10	26
White	May	15	21	10	4	7	3	3	48
	June	1	54	22	4	10	1	3	94
	June	15	97	206	3	11	9	178	504
	July	1		341	47				
Commer-cial	April	15	19	34	6	2	1	33	95
	May	1	18	19	0	1	2	3	43
White	May	15	21	34	2	9	7	4	77
	June	1	92	71	3	8	4	11	189
	June	15	181	391	6	13	6	90	687
	July	1		349	67				
Kansas	April	15	13	35	4	5	6	14	77
Sunflower	May	1	1	8	3	0	15	5	32
	May	15	6	13	1	3	2	4	29
	June	1	29	545	1	10	0	22	607
	June	15	9	258	10	16	8	209	510
	July	1		618	44				
Hildreth	April	15	11	7	3	0	4	23	48
	May	1	22	4	2	4	2	8	42
	May	15	9	13	5	1	0	3	31
	June	1	109	257	3	11	5	33	418
	June	15	63	928	8	17	14	212	1242
	July	1		475	98				

TABLE III—SUMMARY OF THE LOCATION OF THE EGGS ON THE DIFFERENT VARIETIES WITH RELATION TO THE DATE OF PLANTING, MANHATTAN, KANS., 1913–1918

Variety	Planted		Leaf surface Upper	Leaf surface Lower	Silk	Husk	Tassel	Stalk	Total
Boone	April	15	18	0	2	2	1	6	29
County	May	1	8	2	10	2	2	2	26
White	May	15	15	2	12	3	0	16	48
	June	1	23	1	25	10	5	27	94
	June	15	234	41	91	25	40	73	504
Commer-cial	April	15	21	4	53	0	5	12	95
	May	1	6	6	15	1	0	15	43
White	May	15	28	5	27	0	0	17	77
	June	1	62	19	2	3	2	101	189
	June	15	299	66	196	6	36	84	687
Kansas	April	15	12	4	47	2	5	7	77
Sun-	May	1	7	1	21	0	1	2	32
flower	May	15	9	7	7	0	0	6	29
	June	1	77	32	390	43	6	59	607
	June	15	137	54	142	24	42	111	510
Hildreth	April	15	8	2	13	6	6	13	48
	May	1	17	5	3	0	2	15	42
	May	15	13	6	4	0	1	7	31
	June	1	152	28	123	19	10	86	418
	June	15	349	92	562	9	83	147	1242

DISCUSSION OF EXPERIMENTAL DATA

Number of Broods

The number of generations of the earworm present annually in a locality is of special importance in a consideration of many control measures. From the literature quoted by Quaintance and Brues,[1] the number of generations varies from one or two in Ontario to six or seven in southern Texas. Headlee[2] determined the actual number of broods in Kansas to be three, his conclusions being based on frequent egg counts made in the field during 1908 and 1909. The results

[1] Quaintance, A. L., and Brues, C. T. The Cotton Boll-worm, U. S. Dept. Agric., Bur. Ent., Bul. 50, 155 p., 27 figs., 25 pl. 1905.

[2] Headlee, T. J., *op. cit.*

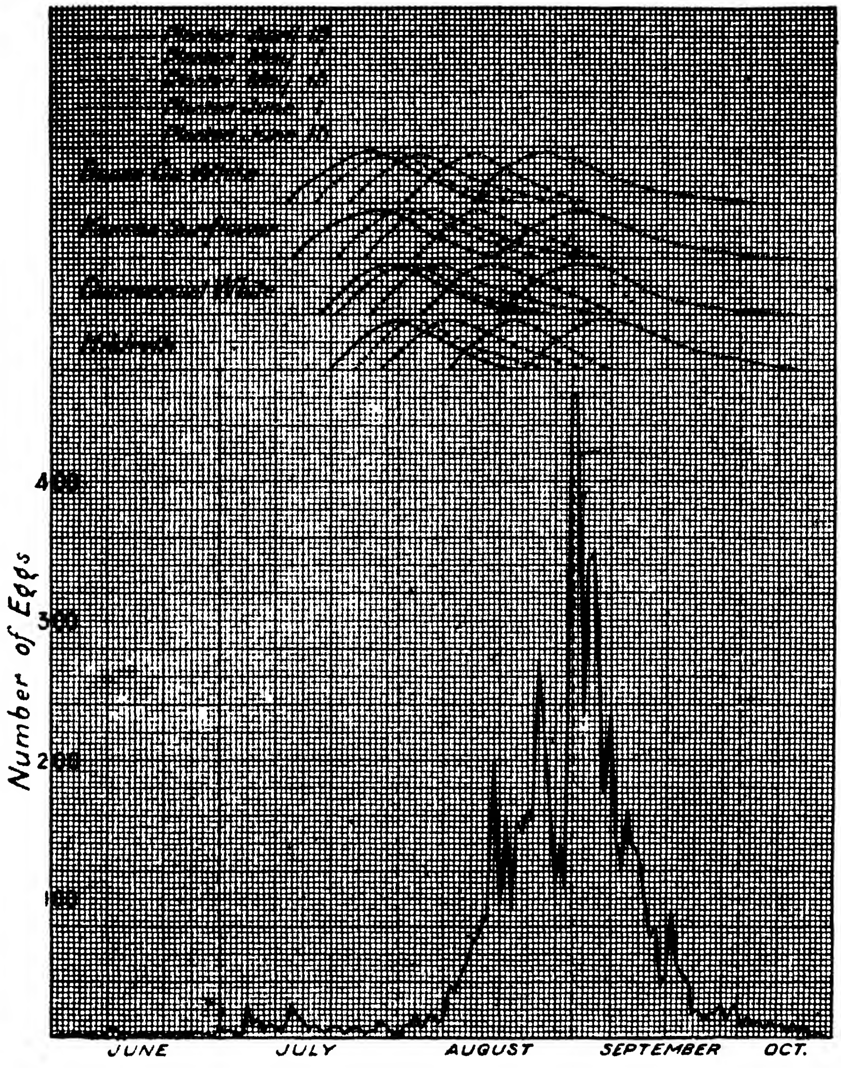


Fig. 7. Graph showing the total number of eggs found daily for the years 1913 to 1918, and the average date of first, maximum and last silking for each variety of corn with relation to the date of planting.

of the present work confirm the findings of Headlee since during the six years that these investigations have been in progress three distinct broods have been in evidence each season. Life history studies conducted under practically natural conditions have shown that a small partial fourth brood may emerge late in the fall. The results of the present study, however, indicate that this brood is of little importance, especially with regard to corn.

Figure 7, which shows the total number of eggs found for each day during the six years, indicates the number of broods and the approximate period that each brood was present. Similar curves drawn for each of the years resemble very closely the curve for the six years, except that there is some variation in the appearance of the broods with the different years due to environmental factors. There is a distinct overlapping of the broods and the point of maximum emergence is not greatly emphasized for the first two broods. The first brood usually begins to emerge during the first week in June, and reaches its maximum about June 15. The second brood appears about July 4, and is at its maximum July 13. The third brood begins emerging about August 10, and the maximum is reached during the last days of the month, and the first days of September. As indicated by the chart, the first two broods are of relatively little importance as compared with the third brood. and in developing a system for the reduction of earworm injury to corn the problem becomes one of protecting it from this last brood.

Silking

The studies at this station in 1908 and 1909 emphasized the fact that the moths exhibited a decided preference for the silks for oviposition, and that a corn plant was in its most attractive stage during the period of silking. Other investigations also showed that a large per cent of the larvæ entering the ear originated from eggs deposited on the silks. With these points in mind it became evident that in the development of many of the control measures it would be necessary to study the silking of the corn plants with especial reference to oviposition, and the data presented emphasizes the importance of this point. The average period of silking for each variety with regard to date of planting is shown in Table IV, and this data is also graphically presented in Figure 1 with relation to the oviposition in the field.

An examination of the table indicates that the date of silking is dependent on the variety rather than on the date of planting. Boone County White was the first variety to begin silking and to reach maximum silking. Kansas Sunflower and Commercial White were a few days later, while Hildreth was the last variety to silk. There was relatively little difference in the period of silking of Boone County White, Kansas Sunflower, and Commercial White, while in the case of Hildreth the period was much shorter. Likewise the period between first silking and maximum silking is shorter in Hildreth than in the other varieties.

It is also of interest to note that while the plantings were made at intervals of two weeks, the dates of silking show a difference of less

Table IV—Average Period of Silking for Each Variety in Each Date of Planting Plot, Manhattan, Kans., 1913-1918

Variety	Planted		Dates of silking: Began	Maximum	End	Period of silking, days	Period between first and maximum silking, days
Boone County White	April	15	7-12	7-26	8-18	37	14
	May	1	7-17	7-31	8-24	38	14
	May	15	7-23	8-4	8-31	39	12
	June	1	8-2	8-14	9-3	32	12
	June	15	8-14	8-27	10-3	50	13
Commercial White	April	15	7-18	7-30	8-24	37	12
	May	1	7-21	8-2	8-28	38	12
	May	15	7-27	8-8	9-5	40	12
	June	1	8-2	8-17	9-8	34	12
	June	15	8-18	9-3	10-10	53	16
Kansas Sunflower	April	15	7-13	7-28	8-19	37	15
	May	1	7-21	8-1	8-26	36	11
	May	15	7-26	8-6	9-3	39	11
	June	1	8-4	8-15	9-19	[illegible]	11
	June	15	8-18	9-2	10-10	53	15
Hildreth	April	15	7-20	7-31	8-22	33	11
	May	1	7-24	8-3	8-27	34	10
	May	15	7-29	8-10	9-3	38	12
	June	1	8-10	8-21	9-8	29	11
	June	15	8-22	9-5	10-11	50	14

than a week between the plantings of April 15 and May 1, and May 1 and May 15. In the later plantings, however, the interval between silking approximates the difference between dates of planting. It is also worthy of notice that the period of silking for all varieties is much longer in the planting of June 15, and that the shortest period occurs in the planting of June 1. In the first three plots there seems to be a tendency for the period of silking to be prolonged with the delay in planting.

The present studies indicate that silking is influenced by a number of factors such as climatic conditions and pollination. Under favorable conditions a plant usually remains in silk from four to eight days. During years of low rainfall and hot winds, fewer silks are produced and many of the silks that do appear are destroyed within one or two days by the hot winds. Pollination is often prevented, delayed or incompleted and the silk may continue to grow to an unusual length and remain green for a much longer time. An examination of the daily records shows that during the period the plants under observation were silking, the majority of the eggs were found on the silks, and any factor that influenced silking had its influence on the number and location of the eggs.

Location of Eggs

A knowledge of the parts of the plant selected by the moths for oviposition is important in developing certain measures of control. This is especially true in working out a spraying program, a time of planting experiment, or in a study of varieties of corn with relation to their resistance to corn earworm injury.

During the six years that these investigations have been in progress, 6,867 eggs (Table V) have been found on the plants under observation. Of these, 2,247 or 32.7 per cent were on the upper surface of the leaves, and 2,100 or 30.6 per cent on the silks.

TABLE V—SUMMARY SHOWING THE LOCATION OF THE EGGS ON 128 CORN PLANTS UNDER OBSERVATION AT MANHATTAN, KANS., 1913–1918

Year	Leaf surface		Silk	Husk	Tassel	Stalk	Total
	Upper	Lower					
1913	358	57	117	30	4	219	785
1914	1,413	499	1,556	100	449	629	4,646
1915	70	7	177	11	11	54	330
1916	48	12	12	1	22	34	129
1917	19	4	59	6	0	4	92
1918	339	66	179	34	124	143	885
Total	2,247	645	2,100	182	610	1,083	6,867
Per cent of total	32 7	9 4	30 6	2 6	8 9	15 8	100 0

As indicated by the table, there is a marked variation in the number and location of the eggs in the different years, a condition influenced largely by the character of the year. An analysis of the data shows that the moths chose the silks, the upper surface of the leaves and the stalks for oviposition. Of these the silks were preferred, and during those years when the plants silked normally, the larger number of eggs were found on the silks. When silking was delayed or prevented, as in 1913, 1916, and 1918, by drouth and hot winds, the upper surface of the leaves and the stalks were selected in preference to the other parts. In considering the places selected for oviposition, it must be remembered that the plant under favorable conditions is in silk from four to eight days, while the other parts of the plant, especially the leaves and stalk, are available during the entire life of the plant. It is also of interest to note that a full grown plant has about twenty square feet of upper and lower leaf surface, and that eggs may be deposited on any part of the leaf.

Relation of Oviposition to Date of Planting

Since the amount of injury is obviously influenced by the number of eggs deposited on the plant, and especially on the ear and silks, a study of oviposition is necessary for the interpretation of the data secured in "a time of planting experiment." The date of planting experiment at this station has been conducted primarily to determine the optimum time to plant corn to obtain the maximum yield and the minimum amount of corn earworm injury. In the present discussion, the relation existing between date of planting and oviposition is considered, the relation between yield and injury being reserved for a future paper.

As was shown in Tables II and III, there is a variation in the number and location of the eggs with regard to the different varieties planted at the same time, and this condition is true with relation to the varieties planted at different dates. A summary of the total number of eggs found on each variety for each date of planting is presented in Table

VI, and in Table VII these data are summarized to show the number and location of the eggs with relation to the date of planting for the six years.

TABLE VI—SUMMARY OF THE TOTAL NUMBER OF EGGS ON EACH VARIETY OF EACH DATE OF PLANTING AT MANHATTAN, KANS., 1913-1918

Variety	Date of Planting					
	April 15	May 1	May 15	June 1	June 15	Total
Boone County White	29	26	48	94	504	701
Commercial White	95	43	77	189	687	1,091
Kansas Sunflower	77	32	29	607	510	1,255
Hildreth	48	42	31	418	1,242	1,781
Total	249	143	185	1,308	2,943	4,828

TABLE VII—SUMMARY OF THE NUMBER AND LOCATION OF THE EGGS WITH RELATION TO THE DATE OF PLANTING, MANHATTAN, KANS., 1913-1918

Date of Planting	Leaf surface						
	Upper	Lower	Silk	Husk	Tassel	Stalk	Total
April 15	59	10	115	10	17	38	249
May 1	38	14	49	3	5	34	143
May 15	65	20	50	3	1	46	185
June 1	314	83	540	75	23	273	1,308
June 15	1,019	253	991	64	201	415	2,943

It is obvious from the results thus presented that April 15 is too early from the standpoint of oviposition for all varieties, with the possible exception of Boone County White, and June 1 is too late. More eggs were laid on the plants planted April 15 than on those planted May 1, and in the case of Commercial White, Kansas Sunflower and Hildreth than on those planted May 15. A decided rise in the number of eggs on all varieties is seen in the plots of June 1 and June 15, and similar results are noted for the important parts of the plant selected for oviposition, although they are not so pronounced. The relationship between the date of planting and oviposition is more clearly brought out in Table VIII which shows the frequency with which the lowest number of eggs were found for each variety with regard to time of planting. In the case of Boone County White, the fewest eggs were found on April 15 planting in three years of the six. In five years the lowest number of eggs on Commercial White were on the May 1 planting, and in three years the same was true for Kansas Sunflower. On the other hand, the fewest eggs on Hildreth were on the planting of May 15 in three years of the six. Summarizing the data for the four varieties during the six years, it is noted that in 12 instances out of a possible 24, the fewest eggs have been found on the May 1 planting. May 15 is second with six instances, April 15 is third, and in one case the lowest number was found on the June 1 plot.

TABLE VIII—FREQUENCY WITH WHICH THE LOWEST NUMBER OF EGGS WERE FOUND ON EACH VARIETY WITH REGARD TO DATE OF PLANTING, MANHATTAN, KANS., 1913-1918

Variety	April 15	May 1	May 15	June 1
Boone County White	3	2	1	
Commercial White	1	5		
Kansas Sunflower		3	2	1
Hildreth	1	2	3	
Total	5	12	6	1

The results of six years' investigation show that there is a direct relation between the number of eggs deposited on a variety and the date of planting, and that there are several factors to be considered in developing an optimum time to plant corn. Headlee[1] pointed out that corn planted about May 1 was less injured by the corn earworm than corn planted April 15 or May 15 and later. He attributed this to the fact that early planted corn passes through its most attractive stage—silking—before the third brood of moths appear, and also that corn planted too early suffers a setback from climatic conditions. The results of the present studies in general confirm the findings of Headlee, and the data on oviposition offer an explanation for this condition. In the light of the present investigations, however, the variety of corn must be considered with relation to the date of planting, since each variety exhibits certain variations with regard to growth, time of silking, period of silking, and maturing. In addition, there are certain morphological characters that may have an influence. As has been pointed out, the number of eggs increases with the delaying in silking and maturing of the varieties, and the early silking and maturing varieties have had the fewest eggs.

The relation between the total number of eggs found daily during the six years, and the average period of silking is shown graphically in Figure 7. As seen by this figure, the maximum emergence of the second brood of moths is about July 10, and the third brood begins to emerge about August 8. Obviously the optimum date to plant corn with regard to the earworm would be at such a time as to bring it into silk between these two broods. A study of the figure shows that corn planted from April 15 to May 15 silks at approximately the same time, being but a few days later for each delay of two weeks in sowing. In the case of the first two dates of planting, the maximum silking period is passed before the emergence of the third brood. The May 15 plot is just reaching its maximum period of silking when the third brood begins to emerge, while the last two plots are in full silk at the time this brood is abroad. The variation in the number of eggs on the varieties in the earlier plots is due largely to the time of silking with relation to the second brood of moths.

From the data shown in Table VIII, it is seen that in the greatest number of instances the lowest number of eggs were found on the May 1 plot, with the May 15 plot second, and the April 15 plot third. In other words, the corn planted April 15 was in silk during the latter part of the period that the second brood of moths were ovipositing. The May 1 plot was in maximum silk about August 1, or at a time when the second brood had practically disappeared, and the third brood had not

[1] Headlee, T. J., *op. cit.*

emerged. An analysis of the data indicates that from the standpoint of the number of eggs deposited, Boone County White can be planted from April 15 to May 1, Commercial White about May 1, and Kansas Sunflower and Hildreth from May 1 to May 15. Summarizing the results for the four varieties, May 1, under favorable conditions, is apparently the optimum time to plant corn to escape injury from the corn earworm.

Relation of Oviposition to Different Varieties of Corn

The number and location of the eggs is worthy of consideration in a study of the resistance of different varieties of corn to earworm injury. Thus far little work has been done along the line of immunity, and in the investigations that have been conducted emphasis has been placed on the presence or absence of larval injury with relation to the morphological characters of the plant. Collins and Kempton,[1] in breeding sweet corn resistant to the corn earworm, considered four protective characters, namely: the distance the husk extends beyond the ear; the thickness of the husk covering; the texture of the husk, and the presence or absence of husk leaves. While a study of the plant characteristics is of great importance in such an investigation it would seem that a study of the oviposition would be important in correlating and interpreting the results. As has been pointed out, the moths show a preference for the silks, and, as will be shown, there is a direct relation between silking and the number of eggs deposited. The present studies also show that fewer eggs are deposited on the husks than on any other part of the plant. In the investigations under discussion, there has been considerable variation in the number of eggs deposited on the four varieties grown in the plots, a condition that has prevailed practically every year. A study of the data presented in Table II shows that in 43.7 per cent of the 32 plots grown in the six years, Boone County White has had the lowest number of eggs, Kansas Sunflower has had the fewest eggs in 28.3 per cent of the plots, Commercial White in 15.6 per cent, and Hildreth in 12.5 per cent.

A comparison of the data summarized in Table III indicates that there is also a similar variation in the location of the eggs on the different varieties, although this difference is not so pronounced. During the time these investigations have been in progress, fewer eggs have been found on all parts of Boone County White, except the husk (Table IX), than on each of the other varieties. Likewise,

[1] Collins, G. H., and Kempton, J. H., Breeding Sweet Corn Resistant to the Corn Earworm. In Jour. Agric. Research, Vol. XI, No. 11, p. 549–572. 1917.

the number of eggs on Hildreth has exceeded those on the other varieties.

TABLE IX—SUMMARY OF THE LOCATION OF THE EGGS FOUND ON THE DIFFERENT VARIETIES, MANHATTAN, KANS., 1913-1918[1]

Variety	Leaf surface Upper	Leaf surface Lower	Silk	Husk	Tassel	Stalk	Total
Boone County White	444	74	277	48	88	158	1,089
Commercial White	575	146	371	23	91	301	1,507
Kansas Sunflower	486	210	699	75	146	301	1,917
Hildreth	742	215	753	36	285	323	2,354

[1] Includes plots of July 1

There are many factors to be considered with relation to the oviposition on the different varieties of corn which offer an extensive field for further investigation. In connection with the data just presented, it is of interest to note that there is an evident relation between the time of silking and maturing, and the number of eggs. Boone County White, which had the lowest number of eggs, is the earliest variety in point of silking and maturing. Kansas Sunflower is second in this respect, Commercial White third, and Hildreth last. Kansas Sunflower, however, ranks third in the total number of eggs found on a variety in the six years, due to the fact that the plant in the plot of June 1, 1914, produced three ears at intervals of several days, with the result that the plant was in silk for an exceptionally long time, and a large number of eggs were deposited on these later silks. In the work under discussion, several instances were noted where plants having rather smooth leaves had fewer eggs deposited on them than on plants having the leaves rough and hairy. Similar observations have been noted in the case of the stalk. The number of leaves borne by a plant and the leaf area are to be considered, since the number present may vary from 8 to 18, and there is a corresponding variation in the leaf area. The number of ears produced by a plant is also important, since a plant may have from one to four ears, each one silking at a little different time and consequently the plant is attractive to the moths for a longer period. Many other factors might be mentioned in connection with the location of the eggs on the different varieties, but since, in the present work, the morphology of the plants has not been followed closely, it does not seem advisable to discuss them further. At the present time an investigation is being conducted along the lines suggested with a large number of varieties, and more extended information is being obtained from this work.

SUMMARY

A study of the oviposition of the corn earworm on different varieties of corn plants with relation to the date of planting and period of silking has been made during the past six years. This work represents

the daily number of eggs deposited on 128 individual plants and the silking period of 128 rows of corn.

Three distinct broods of the corn earworm occur each year, the first brood of moths emerging early in June, the second brood about July 10, and the third brood about August 10. The maximum emergence occurs about two weeks after the first emergence. The first two broods are of little importance in comparison with the third brood.

The date of silking is dependent on the variety rather than on the date of planting. While the plantings were made at intervals of two weeks, the dates of silking show a difference of less than a week for corn planted April 15, May 1, and May 15.

The moths show a decided preference for the silks for oviposition. When these are not available, the upper surface of the leaves and the stalks are selected. Relatively few eggs are deposited on the lower surface of the leaves, the husk, or the tassel.

There is a distinct relation between the date of planting and the number and location of the eggs. From the data presented, April 15 is too early to plant corn from the standpoint of oviposition, and June 1 is too late. The variety of corn, however, is to be considered in developing the optimum date to plant corn, since each variety exhibits certain variations which will have an influence on the number of eggs deposited on it. An analysis of the data indicates that from the standpoint of the number of eggs deposited, Boone County White can be planted from April 15 to May 1; Commercial White about May 1; and Kansas Sunflower and Hildreth from May 1 to May 15. Considering the results for the four varieties, May 1, under favorable conditions, is the optimum time to plant corn to escape the corn earworm.

Considerable variation has been noted in the number of eggs deposited on the four varieties of corn. In 43.7 per cent of the plots grown in the six years, Boone County White has had the lowest number of eggs. Kansas Sunflower has had the fewest eggs in 28.3 per cent of the plots, Commercial White in 15.6 per cent, and Hildreth in 12.5 per cent. A similar variation was noted in the location of the eggs on the different varieties. There are a number of factors to be considered with relation to oviposition on varieties of corn, the principal ones being the time and period of silking, the time of maturing, and certain morphological characters of the plant.

PRESIDENT W. C. O'KANE: The next paper is by R. W. Leiby.

THE CORN-STALK BORER, DIATRAEA ZEACOLELLA DYAR

By R. W. LEIBY, *Raleigh, N. C.*

(Withdrawn for publication elsewhere)

Mr. W. J. Schoene: Evidently the cornstalk borer is not quite so injurious in Virginia as in North Carolina. We have made a few observations and in coöperation with Mr. W. J. Phillips, of the Bureau of Entomology, plowing-out experiments have been in progress during the past two years. The past autumn an attempt was made to check up the injury by the first and second broods of larvæ. This was done by examining each stalk and weighing separately the product of the stalks injured by the various broods. It appears from the several fields examined that the injury by the second brood, that is the injury of the larvæ that attacks the corn when it is nearly mature, is of very little importance. The main injury is caused by the first brood of larvæ.

Adjournment.

Meeting of the Cotton States Entomologists

There was held a meeting of the Cotton States Entomologists at Vicksburg, Miss., and Tallulah, La., on March 1, 2 and 3, to consider several of the most important entomological problems of the cotton belt. The meeting was opened on the evening of March 1, at which time representatives reported on entomological activities in their respective states including teaching, research, quarantine and extension. This was followed by a discussion on the "Pink Bollworm Problem," by Dr. W. D. Hunter. The entire meeting reassembled at Tallulah on March 2, for an examination of the cotton dusting machinery, and then adjourned to the Opera House where Mr. B. R. Coad took charge of the meeting and explained the investigations conducted at the United States Delta Laboratory at Tallulah, La., and the present status of boll weevil poisoning.

Dr. Van Dine made a very interesting address on "Mosquito Control." The remainder of the session was continued at Vicksburg and included a paper on "The Sweet Potato Weevil Fight," by Mr. J. A. Graf, followed by discussions. The European corn borer problem was discussed at some length.

Mr. J. A. Montgomery of the Florida State Plant Board presented a most interesting paper on the "Standardization of Inspection Laws." Following a discussion on this paper a committee was appointed to submit at as early a date as possible a draft for consideration and subsequent adoption by the various cotton states. The meeting ended by a discussion on citrus canker, port inspections, and bee disease inspection, including the enforcement of foul brood laws.

The Association of Southern States Entomologists has no by-laws. Its existence is mutual on the part of entomologists both federal and

state. Any worker in the Southern States is a member of the Association.

It has no schedules for meetings, but the meetings are called whenever any grave matter confronting the entomologists requires serious and immediate attention. All the meetings so far have been for specific purposes, they have been well attended and at every meeting definite policies have been formed for the guidance of the various workers in their respective states in order to achieve uniform and concerted action. At this meeting over fifty representatives, including nearly all the Southern States, were present.

A. F. Conradi,
Secretary.

RESOLUTIONS ADOPTED BY THE COTTON STATES ENTOMOLOGISTS AT VICKSBURG, MISS., MARCH 1, 2 AND 3, 1920

Be It Resolved, That the thanks of this Association be extended to the Association of Southern Agricultural Workers for its invitation to affiliate with that Association, that such invitation be hereby accepted, and that the President of our Association be delegated and authorized to arrange for such affiliation.

Be It Resolved, That it is the conviction of the members of this Association that the European corn borer, Japanese beetle, Oriental peach moth and gipsy moth, foreign pests established in the northeastern United States, constitute a potential menace to the agricultural prosperity of the Southern States, and we urge upon the National Government such steps and appropriations as are necessary to prevent the further spread of these destructive pests in the United States, that earnest efforts should be made to eradicate them.

Be It Resolved, That the experience of Texas and Louisiana with the pink bollworm emphasizes the importance of each state doing systematic scouting work for such dangerous insect pests as the pink bollworm, European corn borer, Oriental peach moth, sweet potato weevil, etc.

Be It Resolved, That it is apparent that there is need for crop pest control laws, with the necessary funds to enforce them, in every state to enable responsible authorities to deal promptly and effectively with dangerous pests wherever they may become established.

Be It Resolved, That while, in our opinion, a wide diversity in climatic conditions, horticultural products and insect fauna makes impractical the application of uniform nursery inspection laws and regulations in all the states of the United States, it is, nevertheless, desirable, in the interests of increased horticultural development and the economical administration of inspection measures, that such laws and regulations be standardized in the Southern States, and uniformity therein secured as far as may be possible, and that to this end it is recommended that nursery inspection laws, or rules and regulations placed in effect in the Southern States include the following essentials:

1. Nursery inspection certificates should remain continuously in force (instead of expiring at a certain date each year) as long as the nursery continues to pass frequent and thorough inspections.

2. Nursery inspection fees and license fees should be abolished.

3. Each state should require a valid and unaltered certificate of inspection of uniform size and appearance attached to each container of nursery stock. For this

purpose is suggested a No. 8 raw hide tag with brass eyelet, with certificate of inspection at top, address space in center, and address of nurseryman at the bottom, and that writing of consignee's address on the tag shall constitute cancellation of that certificate tag for further use.

4. Quarantines should be made as nearly as possible to conform to quarantine rules of the Federal Horticultural Board.

5. Inspection certificate tags should be issued only by the state inspector and printing of copies of these certificates by others should be prohibited as constituting a counterfeiting of the certificate.

6. All certificate tags should be serially numbered and the use of each tag accounted for by the nurserymen sending to the inspector a complete record of the stock sold or shipped under such certificate tag. This in order that the state inspector may promptly inspect past shipments from the nursery where any dangerous pest or disease appears therein.

Your committee is of the opinion that a committee of three members should be appointed by the President of this Association to recommend standard practices in handling the following phases of nursery inspection work:

A. Standardization of fumigation requirements, especially as to dosage and time of exposure.

B. Use of fumigation certificates

C. Listing the plants which should be dipped in insecticides, the strength of such dips and manner of dipping.

D. State requirements applying to interstate shipments.

E. Use of certificate tags and permit tags of the same color in all Southern States during each shipping season.

Be It Resolved, That this Association extend its thanks, and same are hereby extended to Dr. W. D. Hunter, and Mr. B. R. Coad, of the Bureau of Entomology, and their associates for the demonstrations and explanations of boll weevil poisoning methods afforded us at the Tallulah Laboratory, to Mr. B. R. Coad in assisting in compiling the proceedings of this meeting, to the management of the National Park Hotel for providing this Association conveniences for holding its session, and to representatives of the Vicksburg Press and such business interests of Vicksburg as have contributed in various ways to the success of our meetings and the comfort and convenience of our members.

Resolution Concerning the Pink Bollworm Situation, Adopted by the Association of Cotton States Entomologists at Vicksburg, Miss., March 3, 1920

Whereas, The recurrence of the pink bollworm of cotton in the previously infested area in southeastern Texas, the discovery of the insect at points outside the previously known infested area and the discovery of serious infestations in southwestern Louisiana, from which latter area large shipments of cotton seed have been made to other portions of the state of Louisiana, create a critical situation menacing the future of the whole cotton industry of the United States and

Whereas, The situation so created is one of emergency calling not only for the continuation of the present eradication work but also for prompt and drastic measures to prevent the further dissemination of the pest, now therefore

Be It Resolved, By the various entomologists, quarantine officials and other agricultural agents assembled at this meeting of the Association of Cotton States Entomologists at Vicksburg, Miss., this 3rd day of March, 1920, that in order to prevent the further spread of the pink bollworm the Federal Horticultural Board should impose a quarantine against the movement from the states of Texas and

Louisiana into other states of all materials and things which are, or would be likely, to carry and distribute infestation, and this Association respectfully, but nevertheless earnestly and forcefully, urges the Federal Horticultural Board to take such action without unnecessary delay and

Be It Further Resolved, That those in attendance at this meeting as individuals and officials pledge to the Federal Horticultural Board and the state authorities our whole-hearted and unstinted support in the efforts now being made to eradicate the pink bollworm and

Be It Further Resolved, That it is the unanimous opinion of those assembled that the authorities of the several states in the cotton belt should immediately and forthwith impose quarantines, effective at once, against the movement into these states from the states of Texas and Louisiana of all things and materials which are likely to introduce the pink bollworm.

Scientific Notes

Butterfly Migrations. Many instances have been recorded of migrations of large numbers of butterflies, and the following quotations, taken from the writer's diary, may prove interesting additions to the records:

"Brownsville, Texas, June 28, 1912. There was a migration of butterflies, *Libithya bachmanni*, over Brownsville yesterday—flying north close to the ground, almost against a northeast wind, in spite of ———'s theory that insects can migrate only with the wind."

"July 16. Another migration of butterflies (Libithya) flew over the post today, flying almost due east by the thousands. Most of them fly within six feet of the ground, the majority closer. They fly at a rate of eight to twelve miles per hour."

"July 17. The migration of butterflies continued all day, thousands of them flying through the streets of Brownsville."

"July 19. Those Libithya butterflies are flying over town thicker than ever today. There must be millions of them. I judge from their abundance the larvæ must live on mesquite or Texas ebony."

Unfortunately, definite records of wind direction and rainfall were not kept in the diary, as these might have an important bearing upon the time and direction of the migrations. But temperature and humidity were recorded, taken from readings of thermograph and hygrograph maintained in an insectary. These are briefly shown in the following table:

	Max. Tem.	*Min. Tem.*	*Max. Hum.*	*Min. Hum.*
June 28	88	67	96%	45%
July 16	90	73	94%	42%
17	90	73	93%	52%
18	90	75	94%	53%
19	91	76	94%	43%
Average for June	88	74	92%	62%
July	89	75	93%	53%

As seen by the table, there is not enough departure from normal temperature and humidity during the days of flight to in any way account for the migrations.

Another butterfly migration, noted by the writer, took place near La Romana, Santo Domingo, on a large sugar estate at the eastern end of the island. As the writer left Higueral the morning of March 6, it is not known whether the migration lasted longer than the two days.

"Higueral, R. D., March 4, 1914. Observed today, from window of my laboratory, a very considerable migration of large sulphur butterflies, *Catopsilia* (*Callidryas*) *eubule*, flying about northwest at an average height of ten to fifteen feet—some higher, but none close to ground. They linger at no flower or bush, and the flight is very rapid."

"March 5. The migration of sulphur butterflies continued throughout the day, they flying in the same direction as yesterday. As the larvæ of this genus breed on the species of Cassia and Pithecolobium, so large a number of adults must have matured in the scrub growth of Pithecolobium along the seacoast near Romana. It is evident that the large yellow Spilochalcis, that infests the pupæ and keeps this species in check in Porto Rico, does not occur in any abundance on this island."

E. Graywood Smyth.

Roach Control. For several years the buildings of the Michigan Agricultural College have been the home of a flourishing colony of the large American roach, *Periplaneta americana*. The tunnels through which heat, water and electric power are distributed over the campus afford the best of facilities for the roaches to take advantage of changes in food supply and various comforts appreciated by roaches. During all this time the pests have been baited with everything which we supposed might be tempting to a rather well-fed roach, but with indifferent success, the roaches seeming to pay no particular attention to any of our offerings Even Fluorid of soda, both as a dry powder, and mixed in flour, failed to do more than dispose of a few of them, and all this apparently because we had failed to provide an attractive bait in which to place poison. Finally it was noticed that the roaches love to collect on barrels of fermenting honey and water used in making honey vinegar, apparently attracted by the fermenting liquid which seeps through. Accordingly, a thin gruel of cotton-seed meal sweetened with a little molasses was cooked in a steam cooker and to this, when cool, was added a cake of yeast, and fermentation was allowed to start, after which a small quantity of dry, powdered arsenate of lead was stirred in and the offering placed in plates accessible to the roaches. The outcome was really gratifying. The first attempt resulted in the death of several hundred roaches. It is necessary to moisten the bait about once a day since the bait becomes ineffective as soon as it dries out.

R. H. Pettit.

Historic Credits. Sanderson, in his Insect Pests of Farm, Garden and Orchard, figure 80, page 109, credits the illustration, following Riley, to Price, only to receive recently a letter from that gentleman, kindly placed at our disposal, to the effect that while he made the drawing of the "hopperdozer" it was by no means his invention, a credit that he never claimed. The figure was drawn by Mr. Price more than forty years ago when he was a youth and only recently had his association therewith come to his attention, hence the belated note. The inventor of the useful "hopperdozer" has been forgotten, apparently.

E. P. F.

JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

APRIL, 1920

The editors will thankfully receive news items and other matter likely to be of interest to subscribers. Papers will be published, so far as possible, in the order of reception All extended contributions, at least, should be in the hands of the editor the first of the month preceding publication. Contributors are requested to supply electrotypes for the larger illustrations so far as possible. Photo-engravings may be obtained by authors at cost The receipt of all papers will be acknowledged —Eds.

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The resolutions adopted by the cotton states entomologists and printed elsewhere in this issue give expression among other things to the prominent place recently introduced insects have taken among economic pests and voice once more the need of pushing control and exterminative measures. The situation is surely serious with the gipsy moth, the brown tail moth, the European corn borer in the northeastern section of the country, the Japanese beetle in New Jersey and the pink bollworm and the sweet potato weevil in the south, while the oriental peach moth appears fairly well established along portions of the Atlantic seaboard. Each of these insects presents a group of problems in relation to both control in the field and the restriction of spread, not to mention special cases in which extermination is being attempted or urged. This country has suffered enormous losses in the past due to introduced insects, some of which are now of only historic interest while others rank among the most destructive forms. It is possible and perhaps probable that our increasingly efficient quarantines will serve to at least check and may be indefinitely postpone the establishment of still other pests. The efficacy of such measures can be ascertained only by tests on a large scale because a rigid exclusion from one group of ports or one section of the country only makes the dissemination of a pest a little more difficult. Who can say that any but the most rigid quarantine will accomplish more? The probabilities favor a continuance of the conditions outlined above. The invader slowly or rapidly spreading, as the case may be, is normal wherever there is a chance of a species establishing itself in unoccupied territory. It may be possible to develop methods to such an extent

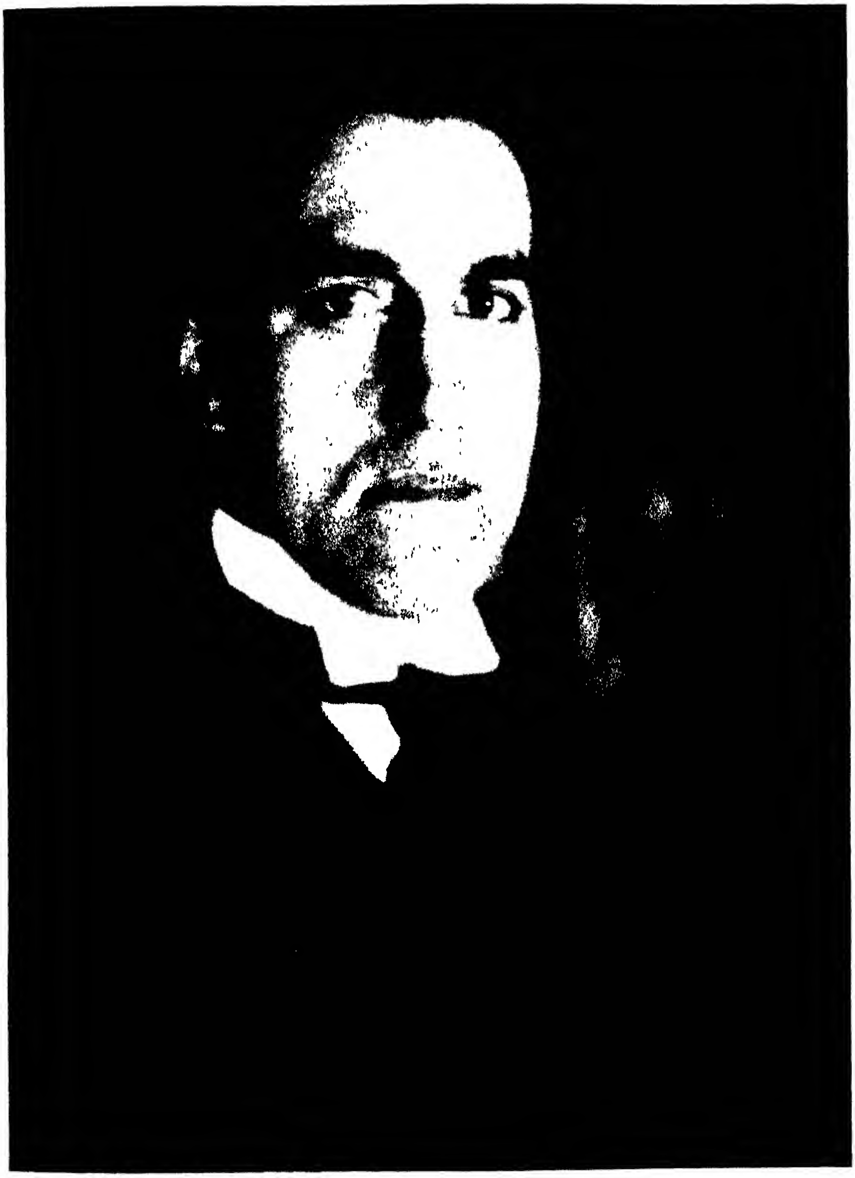
that the dangerous invader, if not absolutely excluded, will be detected so speedily that extermination, re-extermination when necessary, will occur repeatedly and when that time comes the possibilities and limitations of various methods will be better understood than now.

Obituary

CHARLES GORDON HEWITT

The science of entomology and its devotees have suffered an irreparable loss in the untimely death, on February 29, of Dr. Charles Gordon Hewitt, entomologist and consulting zoölogist of Canada. Dr. Hewitt had held these positions since September, 1909. He was the son of Mr. T. H. Hewitt and was born February 23, 1885, at Macclesfield, near Manchester, England. He attended the grammar school and later the University of Manchester, where he was a prize student and received the degree of Doctor of Science. In 1904 the latter institution appointed him lecturer and in 1907 demonstrator in zoölogy. Before leaving England to fill the position of Dominion entomologist he had been a member of several scientific societies. Besides studies on the larch saw-fly and other insects he had written an excellent monograph on the house-fly under the guidance of his teacher, Prof. Sydney J. Hickson. It was first published in three parts in the *Quarterly Journal of Microscopical Science* (1907–09) and in 1910 issued as a book by the University Press of Manchester. It remains one of the most valuable contributions to a subject of great economic importance. After taking up his position in Ottawa, Dr. Hewitt married Miss Elizabeth Borden, daughter of the former premier, Sir Frederick Borden.

The truly remarkable record of development and public service exhibited by Dr. Hewitt's department during the decade of his administration was clearly due to the unusual abilities of the man. Combining a thorough training in zoölogy with rare gifts as an investigator, executive talent of a high order and sympathetic insight into the achievements of other workers, not only in entomology but in biology generally, he could not fail to secure the affection as well as the confidence and admiration of all the men, and particularly the young men, whom he had chosen as aids in building up his department. His scientific interests, however, were not confined to his immediate, official environment. Realizing that very many of the native and introduced animals and the economic problems to which they give rise are identical in Canada and the northern United States, he took an actively constructive part in all deliberations, wherever men were



assembled in either of the sister commonwealths, to discuss practical matters relating to our insects, birds and mammals. At the same time he unceasingly encouraged amateurs, collectors and students to amass data and collections for the purpose of gaining a more satisfactory knowledge of the fauna of British America.

Those who were privileged to know Dr. Hewitt intimately, in the few leisure hours he could spare from his many strenuous and exacting duties, found in him an affectionate and considerate friend and, owing to his intense interest in good literature, music and painting, a very stimulating companion. There was another side of his nature that was not revealed to his friends in the United States as it related to his immediate home environment. This was his ardent interest in the education of boys. He was active in the Boy Scout movement and was president of the Ottawa Boys' Club, which made great progress while he was connected with it.

The great esteem in which Dr. Hewitt was held by his fellow scientists, both in the Dominion and in the United States, is shown by the fact that he was elected a Fellow of the Royal Society of Canada in 1913 and its honorary treasurer in 1914; that he was a member of the Canadian Wild Life Board, and had held presidential positions in three of the leading entomological societies: The Entomological Society of Ontario, the American Association of Economic Entomologists and the Entomological Society of America. He published a number of valuable entomological papers and addresses and had completed a book on the conservation of the wild life of Canada, a subject to which he had devoted much attention during the past few years. That he should have been stricken by pneumonia in the very beginning of what promised to be a long and brilliant career of service, both to his adopted country and to the United States, can only be attributed by his friends to overwork during and since the World War.

W. M. WHEELER.

Reviews

An Investigation of the Louse Problem, by WILLIAM MOORE and ARTHUR DOUGLASS HIRSCHFELDER. Research Publications, Vol. VIII, No. 4 (Studies in the Biological Sciences, No. 3). University of Minnesota, Minneapolis, Minn., July, 1919.

This pamphlet of 86 pages describes the methods of rearing lice, with notes on their biology, pathological effects of their bites, methods of control, the preparation of certain compounds used in the experiments, and bibliography. It is illustrated by six charts showing curves, and two figures. Valuable data are here recorded on the incubation period of eggs, length of instars, and the influence of temperature on egg production. A major portion of the paper deals with control methods, such as laundry processes, effect of hot water, dry heat, soap suds, fumigation, louse powders,

impregnation of underwear, etc. It was found that the lice and eggs are killed in the ordinary processes of laundering khaki and cotton garments at a temperature of about 115° F. for a period of 15 minutes. Woolen garments should be washed for fifteen minutes at a slightly higher temperature of about 120° F. Fumigation of clothing with chlorpicrin, 10 cc. to 2.5 cubic feet of space, for 30 minutes, heated with three one-liter flasks of water at 80° C., proved effective in killing the eggs, except in certain cases where rolled or folded tightly. Impregnation of the underwear was found to be a promising method of control between lousings. For this purpose the authors recommend active chemicals of low volatility like the halogenated phenols, such as dibrommetacresol, dichlormonobrommetacresol, and their sodium salts, dibromcarvacrol, and dibromxylenol. This publication will be especially useful to officers in charge of the sanitation of military camps.

W. E. Britton.

Destructive Insects Affecting Ohio Shade and Forest Trees, by J. S. Houser, Ohio Agr. Expt. Sta. Bul. 332, pages 159–487, plates I to LXX, 1918.

The author has given us in this volume a most excellent comprehensive account, based on practical experience, of some of the more important shade and forest tree insects of Ohio, rightfully stressing the conditions necessary for a satisfactory growth and development of trees as well as methods of controlling the insects which occasionally or frequently injure them. The author emphasizes, first, the selection of suitable species, their proper planting and protection from various mechanical injuries, electric currents and leaking gas. He holds that insect control, while possible under city conditions, is rarely so in the forest or farm lot. The establishment of a municipal tree-treating department is favored on economic grounds and for the guidance of communities the Cleveland ordinance relating to the management, protection and control of street trees is reproduced. There is a detailed and excellent discussion of spraying machinery and accessories, including spraying and banding materials.

The main portion of the work is devoted to brief summary accounts of some seventy-seven of the more important pests, grouped under leaf or foliage insects, scale and other sucking insects and boring insects. The work is illustrated by seventy plates, all of the figures being excellent and a considerable number original.

E. P. Felt.

Current Notes

Conducted by the Associate Editor

Dr. T. J. Headlee addressed the Connecticut Pomological Society at Hartford, Conn., February 12.

Mr. Arthur Gibson has been appointed acting Dominion entomologist *vice* Dr. C. Gordon Hewitt, deceased.

Mr. Kenyon F. Chamberlain, assistant entomologist, Connecticut Agricultural Experiment Station, resigned March 1.

Dr. C. L. Metcalf has recently been promoted from assistant professor to professor of entomology in Ohio State University.

Prof. George Macloskie, for thirty-one years professor of biology at Princeton University, and professor emeritus since 1906, died January 4, 1920. Between 1880

and 1891 Professor Macloskie published several papers, chiefly morphological and anatomical, dealing with insects.

Mr. Archibald H Ritchie has resigned his official position in Jamaica to accept a position with sugar planters at Albion Estate, Yallahs P. O.

Mr. R. H. Hutchinson of the Bureau of Entomology resigned March 15, to accept a position with the H. K. Mulford Company, Philadelphia, Pa

The American Honey Producers' League was organized at the meeting at Kansas City, Mo., January 6 and 7, called by the National Beekeepers' Association.

The thirty-first annual meeting of the California State Beekeepers' Association was held at the auditorium, Exposition Park, Los Angeles, on February 6 and 7.

The thirty-first annual meeting of the Pennsylvania Beekeepers' Association was held at Harrisburg on January 21, and was one of the most successful ever held in that state.

Mr. J. C. Crawford, for several years in charge of the Hymenoptera at the U. S. National Museum, and a specialist on the Chalcididæ, resigned his position in January, 1920.

Mr. M. J. Moloughney, entomological branch, Canadian Department of Agriculture, is in ill health, and a three months' additional sick leave was granted him from February 9, 1920.

Wisconsin has a new apiary inspection law now in force which prohibits shipping bees into the state except on permit of the state entomologist, unless accompanied by an official certificate of inspection.

The meeting of the National Beekeepers' Association was held at the Statler Hotel, Buffalo, N. Y., March 9-11, and the program included addresses by Dr E. F. Phillips, Prof. F. B. Paddock and Prof. George H Rea.

Mr. R. R. Reppert, assistant state entomologist of Virginia, has resigned to accept the position of extension entomologist in the state of Texas. Mr. Reppert expected to assume the duties of this position early in March.

The laboratory of the Bureau of Entomology at Grand Junction, Colo., where investigations of the codling moth have been carried out for the past few seasons in cooperation with the Colorado Agricultural College, has now been discontinued.

Mr. G. E. Sanders, Annapolis Royal Laboratory, and Mr. W. A. Ross, Vineland Laboratory, Entomological Branch, Canadian Department of Agriculture, attended the meetings of the New York State Fruit Growers' Association at Rochester, N. Y

Mr. E. H. Strickland, Entomological Branch, Department of Agriculture, Ottawa, Canada, has recently visited the Museum of Comparative Zoology and the Bussey Institution of Harvard University where he spent six weeks studying mites under Dr. Banks.

Recent appointments in the Bureau of Entomology are announced as follows: Perez Simmons, pea and bean weevil investigations, Alhambra, Cal.; Earl R. Van Leeuwen; W. H. Carpenter; Curtis P. Clausen; A. L. Johnson, Alabama; J. C. Bridwell, Honolulu.

The following resignations are reported from the Bureau of Entomology: F. B. Milliken, to enter commercial work; H. H. Stage, to become entomologist of the St. Louis and Southwestern Railway Lines; Dr. Roger C. Smith, to accept a state position; George B. Fisher; Roger J. Chambers; A. P. Swallow, to enter commercial

work; E. R. Jones; E. G. Baldwin; H. A. Scullen; H. D. Smith; E. M. Searls T. D. Urbahns, to accept a position with the California State Department of Agri culture; A. B. Jarrell; H. D. Smith.

Mr. C. A. Reese has severed his connection with the State Department of Agriculture, Charleston, W. Va., as state apiarist to take charge of similar work for the Florida Plant Pest Board under Prof. Wilmon Newell. Mr. Reese took up his duties at Gainesville, Fla , March 1, 1920.

The following recent appointments in the Entomological Branch, Canadian Department of Agriculture, are announced: Mr. Ralph Hopping, Division of forest insects; Miss M. Nash, temporary clerk stenographer at headquarters; Miss J. R. Oliver, temporary clerk stenographer at Vineland Station Laboratory.

Resignations in the Entomological Branch, Canadian Department of Agriculture, are announced as follows: Mr. C. C. Rokeby, temporary superintendent of fumigation, Windsor; Mr. R. N. Chrystal, forest insects; Mr. E. A. McMahon, Annapolis Royal Laboratory, to accept a position with the John Cowan Chemical Company of Montreal.

Dr. J. H. McDunnough, officer in charge of the National Collection of Insects, Dominion of Canada, has been promoted to the position of chief of the Division of Systematic Entomology. On account of lack of space for the National Collection of Insects, tenders have been issued for ten new steel cabinets; these will hold 250 insect drawers.

In an endeavor to prevent the further spread of the apple sucker (*Psylla mali* Schmid) by artificial means, a quarantine has been placed on the infested district in the vicinity of Wolfville, N. S. No apple stock, including seedlings, scions, buds or grafts, may be removed from the quarantined area unless it is accompanied by a certificate of inspection.

Mr. Curtis P. Clausen, a graduate of the University of California, has been appointed by the Bureau of Entomology, specialist in insect parasites of the Japanese beetle, and will soon sail for Japan, where he will undertake a study of all natural enemies of this insect in that country, with the view of introducing the natural enemies of the beetle into New Jersey.

Mr. W. H. Goodwin. Bureau of Entomology, was to have entered upon the investigation of mill insects, December 1 Because of ill health he asked for a leave of nine months without pay. He has accepted employment with a commercial firm and, in view of his practical experience along the line of flour-mill insect control, it is probable that he will continue in commercial work.

The Bureau of Entomology Laboratory at Seaview, Wash., where investigations of cranberry insects have been made during the past two seasons in coöperation with the Washington Agricultural Experiment Station, has been discontinued, and H. K. Plank will be placed in charge of the Bureau's laboratory to be reëstablished in Michigan for the purpose of making investigations of deciduous fruit insects in that region.

A hearing was held in Washington, D. C., February 24, before the Federal Horticultural Board in relation to quarantine restrictions on account of the European corn borer. Among the entomologists present were: E. N. Cory, Maryland; J. G. Sanders, Pennsylvania; T. J. Headlee, New Jersey; W. E. Britton, Connecticut; W. C. O'Kane, New Hampshire; and Messrs. C. L. Marlatt, W. R. Walton, D. J. Caffrey, E. R. Sasscer and L. H. Worthley, Bureau of Entomology; Massachusetts was represented by Dr. A. W. Gilburt, commissioner of agriculture, and New York

State, by Mr. G. G. Atwood, chief of the Bureau of Plant Industry. The arguments were against quarantining states not known to be infested, and in favor of allowing shelled corn, vegetables, nursery and flower plants to move under a system of permits, inspection and certification. Quarantine 43 is the final outcome.

The following transfers are announced in the Entomological Branch, Canadian Department of Agriculture: Mr. P. N. Vroom, Fredericton Laboratory, temporarily to headquarters, Ottawa; Mr. A. E. Kelsall, Annapolis Laboratory, three months' leave of absence to study the chemistry of insecticides at McGill University; Miss Grace McCarron, Fredericton Laboratory, to clerk stenographer at headquarters, Ottawa.

Officers of the Brooklyn Entomological Society for 1920 are as follows President, W. T. Davis, vice-president, J R. de la Torre Bueno; treasurer, Rowland F. McElvare; recording and corresponding secretary, Dr. J. Bequaert; librarian, A. C Weeks; curator, George Franck; Publication Committee, J. R. de la Torre Bueno, editor, George P. Englehardt, Dr. J Bequaert· delegate to council of New York Academy of Sciences, Howard Notman.

Dr. R. R. Parker, assistant entomologist, Montana State Board of Entomology, in charge of tick eradication work in the Bitter Root Valley, Montana, who was to have sailed for Poland February 1 with an International Red Cross expedition to study typhus fever for a three months' period, has been delayed and the expedition has sailed without him. Dr. Parker first had influenza, and complications which have since arisen have made a surgical operation necessary.

Recent transfers in the Bureau of Entomology are as follows: Vernon A Roberts (temporarily), to Orlando, Fla.; M C. Lane, Berkeley, Cal., to Forest Grove, Ore.; B. G. Thompson, Forest Grove, Ore , to Berkeley, Cal.; A. H. Beyer, W. B. Cartwright, T. S. Wilson, R. J. Fiske, W. G. Bemis, H. B. Carpenter, W L. Miles, temporarily to pink bollworm work; Thomas H Jones, to Fort Myers, Fla., C. M. Packard, Hagerstown, Md., to Cal., B R. Leach, Dover, Del., to Riverton, N. J.; William A. Hoffman, Brownwood, Tex., to Riverton, N. J.

Mr. J. C. Bridwell, a graduate of the Iowa Agricultural College, has been appointed to the Bureau of Entomology as "specialist in Bruchidæ and their parasites," with headquarters at Honolulu The increased plantings of the introduced algaroba tree throughout the Hawaiian Islands has led to the development, during the past ew years, of the manufacture of a valuable stock feed from the seed pods of this tree. Chemical analyses prove that the algaroba bean weevil (*Bruchus prosopis*), which was introduced into the islands along with its host plant, is responsible for a large loss in the protein content of the feed. Because of the equable climate and the ripening of successive crops of pods throughout the year, the infestation of the pods on the tree is heavy and probably will not yield to artificial control measures. Several parasites already present in Hawaii may be accomplishing all that parasites can in limiting the damage caused by the weevil.

Lord Walsingham (Thomas de Grey) of Merton Hall, England, died December 3, 1919. He was born July 29, 1843, and early became interested in the study of the Microlepidoptera in which for many years he has been considered one of the leading authorities of the world. His entomological activity covered more than half a century. He made a collecting trip to the Pacific coast of the United States in 1871–72, and was greatly interested in the insect fauna of America and described many new species. Among his many published papers are North American Tortricidæ, British Museum, 1879; Pterophoridæ of California and Oregon, London, 1880;

Some North American Tineidæ, 1881; North American Coleophoræ, Trans. Ent. Soc., London, 1882; Revision of the Genera *Acrolophus* Poey, and *Anaphora* Clem., Trans. Ent. Soc., London, 1887; Steps toward a Revision of Chambers' Index, with Notes and Descriptions of New Species, Insect Life, Vols. I–IV, 1888–92; The Microlepidoptera of Teneriffe, 1907; Bilogia Centrali Americani, Vol. IV.

The brown-tail moth work in New Brunswick was closed down in the middle of January. No nests have been found during the past two years. Only four men were employed this season, and the greater portion of the territory was scouted with the aid of a car. In Nova Scotia 267 brown-tail nests were collected up to January 31; this is a considerable reduction as compared with previous years. The brown-tail moth is still continuing to breed in this Province and local infestations are uncovered from time to time. The majority of scouts were discharged on January 31.

A new sweet-potato weevil district has been discovered in the state of Mississippi, embracing about fifteen infested properties east of Ocean Springs, along the line of the Southern Railway, probably caused by the shipment of sweet-potato plants from the infested section in Louisiana. It is worthy of note that the sweet-potato crop, according to statistics published in the December issue of the *Monthly Crop Reporter* of the Department of Agriculture, is greater in value by about $20,000,000 than that of last year. The six Gulf States, in which infestations of the sweet-potato weevil have been noted, produce more than 50 per cent of the crop for the United States

Mr. Ralph Hopping, in charge of forest insect investigations in British Columbia for the Division of Forest Insects, is supervising control operations in the beetle-infested yellow pine of the Coldwater Valley and the adjoining district west of Merritt and Canford, B. C. The work is undertaken in coöperation with the Provincial Forest Branch of British Columbia, the Dominion Forest Branch and local lumber companies. The control methods include modified logging operations, the salvage of the timber when this is feasible, and the burning of the slash. Mr. Hopping is having excellent success in organizing this important work, and we entertain great hopes that a large body of fine timber will be saved thereby.

The annual meeting of the entomological workers in Ohio institutions was held at the Ohio State University, Columbus, Ohio, January 29, 1920. Morning, afternoon and evening sessions were held, and the following program was rendered: Symposium: The Function of My Department in the Work of the State, H. A. Gossard, entomologist, Experiment Station; Raymond C. Osburn, head, Department of Zoölogy and Entomology, Ohio State University; E. C. Cotton, chief, Bureau of Horticulture. Papers: Herbert Osborn, Notes on Leaf-Hoppers; H. E. Evans, The Effect of the Federal Plant Quarantine Act on the Nursery Business; W. M. Barrows, The Changes Which Take Place in Insect and Arachnid Muscle During Metamorphosis; T. L. Guyton, Results of the Use of Magnesium Arsenate as an Insecticide in 1919; W. H. Larrimer, La Fayette, Ind., Army Worm Control Through County Organization; L. L. Huber, Two Parasites of the Resplendent Shield Bearer; Annette F. Braun, The Study of Microlepidoptera; C. L. Metcalf, The Use of Insect Genitalia in Classification; W. C. Kraatz, Remarks on the Insect Fauna of Mirror Lake; C. H. Kennedy, Life Histories of the Dragon Flies; H. A. Gossard, The Relation of Bees to Fire Blight; E. L. Wickliff, Insect Food of Young Bass; H. L. Dozier, Observations on Some Florida Insects; R. S. McKay, Observations on Orthoptera in Southern Ohio in 1919; E. W. Long, Apiary Inspection in Relation to Entomology; W. V. Balduf, Soy Bean Insect Investigations. Round Table: The Hessian Fly in Ohio in 1919, T. H. Parks, leader. Papers: R. C. Osburn, Some Remarks on the Genus Syrphus; F. H. Crecker, Distribution of Fresh Water Sponges

by Caddis Fly Larvæ; J. S. Hine, Blood-Sucking Insects Observed on the Katmai Expedition; E. A. Hartley, Some Observations on Bark Beetle Depredations in Western Yellow Pine in Oregon; P. R. Lowry, Remarks on the Dactylopiinae of Ohio; J. S. Houser, The Onion Maggot. The following officers were elected: President, J. S. Houser; vice-president, H. J. Speaker; secretary, T. H. Parks.

A conference of entomologists was held at the Grand Central Terminal Building, New York City, on March 31, to consider standardizing formulas for dusting; contact insecticide dusts, the advisability of arranging experiments in different states to obtain more accurate information regarding dusting in comparison with spraying for the control of orchard insects. The following entomologists were present:—Dr. E. P. Felt, Albany; Professor P. J. Parrott, Geneva; Professors G. W. Herrick and C. R. Crosby, Ithaca, N. Y.; Dr. T. J. Headlee, New Brunswick, N. J.; Professor H. E. Hodgkiss, State College, and Mr. S. W. Frost, Arendtsville, Pa.; Dr. W. E. Britton, New Haven, Conn. Dr. A. L. Quaintance, Bureau of Entomology, Washington, D. C.

The seventh annual meeting of the New Jersey Mosquito Extermination Association was held at the Chalfonte Hotel, Atlantic City, February 5 and 6. The first session was called to order at 8 p. m., Thursday, February 5, by the president of the association, Walter R. Hudson, with an address, "The New Jersey Mosquito Problem and Its Solution." This was followed by a paper by Dr. L. O. Howard, "Objects, Methods and Results of Mosquito Control in Different Parts of the World." The speaker gave probably the most complete résumé of the work and the published results that has been prepared and which will be of much value for reference when published in the proceedings of the association. The second session, Friday forenoon, was given up to a "Symposium of the 1919 Work of Mosquito Control and Its Results." Reports of the county commissioners from twelve counties were read, followed by a summary of the state and county work by Dr. T. J. Headlee. At the afternoon session reports were presented on the methods and results of mosquito work in Connecticut, Nassau County, New York, Pennsylvania, and New York City. The closing session at 8 p. m. was opened by an address, "Objects and Aims of the Mosquito Work of the Department of Conservation and Development," by Alfred Gaskill, director. The attendance was less than at some of the previous meetings due to the severe storm which started February 4, and continued during the two days of the meeting. Several important papers were omitted as the speakers were unable to make connections due to delayed traffic, but the time was fully taken up with interesting discussions which would have necessarily been omitted if the complete program had been carried out.

GIPSY MOTH CONFERENCE

On February 3, 1920, a meeting was held at the State House, Boston, Mass., to discuss the present status of the gipsy and brown tail moths in New England, also to exchange ideas and views concerning the work of suppression.

Among those present were:—M. H. McIntyre of Maine; Professor W. C. O'Kane, W. A. Osgood and Philip Ayers of New Hampshire; H. L. Bailey of Vermont; Harry Horovitz of Rhode Island; I. W. Davis of Connecticut; W. A. L. Bazeley, Commissioner of Conservation of Massachusetts, and members of the State Gipsy Moth and Forestry Departments; L. S. McLaine of the Dominion of Canada; Dr. L. O. Howard, Chief of the Bureau of Entomology; Mr. A. F. Burgess, in charge of the gipsy moth work in New England for the Bureau, and members of the field and laboratory force.

The morning session was given over to the discussion of the gipsy and brown tail moth situation in the several states by their representatives.

Several centralized infestations of the brown tail moth were reported, but it was thought that by proper treatment, these centers of infestation could be eradicated.

It was the consensus of opinion, however, that in order to cope with the gipsy moth in its now largest area ever infested, larger appropriations are imperative, not only on account of this increase of territory but also on account of the higher prices of equipment, supplies and labor.

The representatives of the various states realized the seriousness of the situation and emphasized the need of increased Federal appropriations because of the inability of their several states to furnish sufficient funds to carry on all the work that should be done. With this in view, the recommendation of Dr. L. O. Howard to have the appropriation increased $100,000, was heartily endorsed.

Mr. L. S. McLaine of Canada expressed his fears of the present spread of the gipsy moth, which is about 37 miles from the Canadian border, on account of the favorability of the territory to which it is spreading.

After luncheon at the City Club, through the courtesy of Mr. W. A. L. Bazeley, Commissioner of Conservation of Massachusetts, the afternoon session was given over to papers by the various members of the Federal Bureau on problems such as wind spread, non-hatch of gipsy moth egg clusters, cranberry bog investigations, quarantine, forest management, and the present status of the parasites.

The coöperation of the infested states with the Federal Bureau was manifested by the harmonious discussions of the various problems.

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Proceedings of the Thirty-Second Annual Meeting of the American Association of Economic Entomologists

(*Continued from p. 256*)

Afternoon Session, Friday, January 2, 1.00 p. m.

After the conclusion of the business, a number of papers were read.

President W. C. O'Kane: The first paper is "The Cornpith Weevil," by G. G. Ainslie.

THE CORNPITH WEEVIL (CENTRINUS PENICELLUS. HBST.)

By George G. Ainslie, *U. S. Bureau Entomology, Knoxville, Tenn.*

In 1911 it was first noted that in Tennessee the upper two or three nodes of corn stalks are very commonly bored by a curculionid larva. Whenever possible since that time notes have been made on the insect doing this work and now when there is so much interest in corn stalk borers it will be well to set out the main facts in its life history.

The work, for it can hardly be called injury, is done by the larva of *Centrinus penicellus*, a small brownish-yellow rhyncophorous beetle whose host plant and life history have never been recorded. Dr. W. D. Pierce places the species in the genus *Geraeus* but Blatchley and Leng (1916) retain the name *Centrinus.*

The insect passes the winter as a milk-white larva curled in a small spherical cell in the earth. The first beetles make their appearance about July 1 increasing gradually in numbers until early August. Eggs are laid during this period and the larvæ feed through the rest of the summer reaching their growth and leaving the corn stalk for the earth about October 1. There is but one generation a year.

Blatchley and Leng give the distribution of the species as "New York to Iowa and Nebraska, south to Florida and Louisiana, scarce in southern Indiana." My information, so far as it goes, coincides closely with this. I have found the larvæ common in corn along the Ohio river from West Virginia to its mouth and in middle Tennessee and Kentucky the beetles sometimes become noticeably abundant. It is reported from numerous places in Maryland, New Jersey (Smith, 1910), North and South Carolina, Georgia, Alabama and Mississippi but I have failed to find it in Florida. Forbes and Hart (1900) record its distribution as "Atlantic states to the Rocky Mountains." Bruner (1891) records it from Nebraska. In addition, I have reports of what may prove to be this species from South Dakota. Just what factor it is that determines the northern limit of distribution is not known but it is suggested that it may be the depth to which the ground freezes during the winter. If this is true the species will work its way northward during a series of years with mild winters only to be thrown back by one with unusually low temperatures. An interesting observation in support of such a theory was made by Mr. C. M. Packard at a locality in Maryland where the elevation within 35 miles rises from 500 feet to 2,100 feet. At the lower altitude the species was abundant but higher up it disappeared entirely.

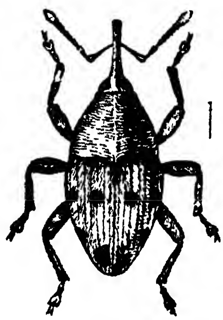

Fig. 8.—*Centrinus penicellus*, dorsal view.

Corn seems to be the main and most common food plant though larvæ which seem in every respect to be the same have been found in the stems of *Panicum crusgalli* and *P. dichotomiflorum*. It is very likely that other large grasses are also attacked. In one instance in middle Tennessee it was reported that millet grown for seed was being injured by a stem-boring curculionid larva and from the few immature larvæ I saw it is merely suggested that the work may have been that of this species. So far as our observations go it does not attack sorghum, broom corn or other closely related plants. On corn no injurious effects have been connected with its presence.

In corn the egg is laid in the main stem either in or immediately below the tassel. Even though the beetles are present no eggs are laid until the tassel is pushed out beyond the sheath thus exposing the culm. Very shortly, usually, after this has occurred the inconspicuous punctures of the beetles may be found on the stem but seldom or never on the tassel branches. The puncture is characteristic and unlike that made by any other insect with which I am familiar. It is elliptic in shape with its long axis perpendicular, open, about .20 mm. by .40

mm. in size, its margins often a little ragged and at first concolorous with the surrounding stem but soon darkening for a short distance back from the puncture. The number of punctures varies according to the abundance of the beetles and the length of time the stem has been exposed. Counts at several times and places have given the number from one to eleven per plant, the average between four and six. Not all of these are egg punctures as many seem to be made for feeding purposes only. Externally the two are indistinguishable. I have never seen the punctures elsewhere than on the upper part of the stem and in the tassel but Mr. E. H. Gibson reports that in Mississippi the beetles commonly feed on the midribs of the leaves where the tissue is of much the same character as in the stem.

Fig. 9.—*a*, Section of corn stalk just below tassel, showing egg punctures; *b*, Section with sheath removed to show exit hole of larva.

In making the puncture the beetle stands transversely on the stem and after cutting through the bark consumes enough of the pith to form a small cavity which always lies to the side of the opening, never above or below it, indicating that the beetle does not rotate while feeding as do many rhyncophora. The operation requires from thirty minutes to an hour to complete and if it be a female preparing for an egg she then steps forward, presses the tip of the abdomen to the puncture and inserts the egg. When in situ the egg lies in the pith a millimeter or more from the outside surface and usually distorted from the unequal pressure. The egg is so soft that its shape is never twice alike. It resembles nothing so much as a bit of water-clear jelly. When freed from pressure it is oval or elliptical in outline, sometimes a little flattened or slightly reniform, or almost cylindrical, .670 to .699 mm. long and 0.40 to 0.42 mm. broad, considerably larger than the puncture through which it enters. The chorion is very tenuous and without markings save for small accidental wrinkles.

As development proceeds the egg becomes milky and a day or two before hatching the brown mandibles can be seen through the chorion. One egg whose deposit was observed on July 22 had not hatched when dissected from the stalk on July 29 but the mandibles were plainly visible so the egg stage is probably but little over a week. After the nidus is once opened it is difficult to keep the egg from drying or molding for more than a day or two.

The hatching is nothing more than a rupture of the delicate membrane inaugurated and assisted by the mandibles which can sometimes be seen slowly opening and closing before the membrane breaks. The

membrane once ruptured and pushed aside, the head slowly changes to brownish yellow and the minute grub begins to feed on the delicate pith cells surrounding it. It turns at once downward and cuts a straight passage so small at first as hardly to be visible. The exact number of instars has not been accurately worked out. It would seem that this could be determined from the head casts left in the burrow and occasionally one of these can be found but after the first or second instar the larva becomes more active and instead of continuing directly downward it constantly moves up and down in the burrow enlarging it and crushing any exuviæ into hopeless bits. I have made head measurements of a large number of alcoholic larvæ but the sizes grade imperceptibly into one another, making any separation on this basis impossible.

When the larva reaches the first node it pauses for some time either because the septum is harder to cut through or because the tissue just at the node is more succulent and attractive. In either case the node seems to be a favorite resting place and quite a cavity is cut out and partially filled with the fine, fluffy, pale yellow frass. When a stalk is opened the larva, in the majority of cases, will be found in or near this nodal cavity. Between the nodes the larva continues the burrow as a clean straight tunnel, a little wavy in direction but seldom with branches or side passages. Close to the egg puncture and also at the nodal cavities, the passage is somewhat discolored, yellow or brownish, elsewhere perfectly white and clean. The presence of the larvæ is most easily determined by a smooth cut between the first and second nodes from the top when the passage, if present, appears as a clean round hole. I have thought that in some cases I could locate infested plants by external examination and it may be that the tassels and the upper nodes of infested plants become brown and dry a little sooner than the others but this method is not certain. In no case have I observed from the work of this insect any breaking over of the tassels, but an instance of this was noted at Hagerstown, Md., September 29, 1919, by Mr. C. M. Packard. Broken tops were found, many of them on infested plants, but as not all of the broken stems were infested it is hardly possible to attribute the condition to this insect alone. As these broken-over tassels are one of the most conspicuous evidences of the work of the European corn borer (*Pyrausta nubilalis*) further observations on this point are desirable. As each node is reached the larva delays and enlarges a cavity there. Occasionally the larva completes its growth at the top node, more commonly at the second and third and only very rarely does it reach the fourth node from the top.

Although very often more than one egg is laid in a single plant it is very unusual for more than one of the larvæ to reach maturity. All

others seem to be crowded out or starved by having no fresh pith to work in. Whenever two or more larvæ do persist for a time the pith is completely riddled with burrows and changed to a mass of finely granular frass.

In Tennessee most of the eggs are deposited late in July and early in August, and two months later, about October first, practically all the larvæ are mature. It is surprising how simultaneously the larvæ in any given field mature and leave the stalk. It has repeatedly happened that in a field where scarcely an exit hole could be found one day, only an occasional larva could be found a day or two later. In middle Tennessee this general exodus occurs very near October 1. In almost every infested field a few larvæ can be found in the stalks a month or more beyond the usual emergence date but such larvæ are generally smaller and immature. They are either larvæ hatching from very late laid eggs and without sufficient time to feed to maturity or those starved by the premature or rapid drying of the pith as the plant ripened or was killed by frost.

The burrow ends, usually, at or near a node, sometimes running an inch or two below it. The exit hole may be at a node or anywhere between but the most usual place for it is just above a node, within an inch or two of it. This would seem to be a rather unsatisfactory point for the ensheathing leaf base often so tightly enfolds the stem that the larva to escape must cut its way through both the stem wall and the leaf sheath. In rare instances the sheath of the leaf below also overlaps this one so there are three tough walls to be cut before the larva is free. Often, however, after cutting through the stem wall there is space enough behind the leaf sheath for it to escape in which case the exit hole is not visible until the leaf base has been removed.

The emergence hole is not round but more often distinctly oblong, with its long axis parallel to the stem, about .75 mm. wide and 1.50 mm. long. The hole appears too small to permit the passage of the satiated larva but observation shows that if the head emerges the body can follow. The edges of the hole are often not clean cut. The exit hole, like the egg puncture, is characteristic of this species and once observed can hardly be mistaken.

There is nothing especially noteworthy in the rest of the life cycle. The larvæ simply wriggle free from the corn plant, fall to the ground and enter the soil at some crack or irregularity. In dense soil they go down but three or four inches, in a cultivated field or in mellow ground from eight to ten inches, often below the furrow slice. One was found in the center of a large clod lying on the surface. After reaching a sufficient depth the larva by rotation forms a smooth compact-walled, more or less spherical cell in which it lies awaiting the time of pupation the following summer.

As larvæ have never been carried entirely through their transformations under observation neither the exact date of pupation nor the length of the pupa stage is known.

All my notes and all the collection records to which I have access show that the beetles make their appearance first about July 1. From this time on they slowly increase in number, reach their maximum early in August and then gradually disappear. They have been taken as late as September 30 in Tennessee and Kentucky.

In the field the beetles are rather difficult to capture. They are always alert and at the least disturbance take wing almost as readily and quickly as a fly. When cornered they feign death and drop instantly but take flight after falling a few inches. During the day in clear weather they remain usually partly hidden among the leaves and in the throat of half grown corn plants, coming out to feed and oviposit toward dusk and on cloudy days.

The percentage of infestation even in neighboring fields varies considerably and may reach practically 100 per cent. The date at which the corn tassels emerge seems to be the determining factor, the very late planted corn being almost entirely free of larvæ. It does not seem possible to plant early enough to avoid their attacks for the earliest tassels to appear are at once attacked. It is probable that many of the beetles emerge before that time and feed sparingly on various plants while awaiting their favorite food.

References in literature to the biology of this species are few and unimportant. It was described in 1797. Bruner (1891) lists it among insects found attacking sugar beets. Riley (1893) notes that occasionally the beetles feed on green corn kernels. Forbes and Hart (1900) report its work on sugar beets as injurious. Hunter and Hinds (1905) list it among the insects mistaken for the boll weevil and note that the beetles are found in flowers. Pierce (1907) lists it but adds nothing new to its biology. The adult is fully described and its distribution given in some detail by Blatchley and Leng (1916). It seems very strange that it has been overlooked by Forbes and his workers in their exhaustive studies of corn insects for it must occur at least in southern Illinois.

The only natural enemy of this species so far observed is a minute cecidomyid, the salmon-yellow larvæ of which enter the egg punctures, feed on the eggs and sometimes perhaps even attack the small grubs. These predators have been repeatedly observed in the burrows in Tennessee and Mr. P. Luginbill sent me from Columbia, S. C., a partially grown beetle larva very evidently killed by the maggot which was still feeding upon it. This one was reared and developed into a delicate midge with banded wings. It has not been determined.

I quote herewith the description of the adult given by Blatchley and Leng (1916):

"Oval or subrhomboidal, feebly flattened above. Piceous-black, densely clothed with narrow, pointed, dull yellowish scales, those of thorax arranged transversely, those of elytra forming two or three nearly regular rows on each interval; each elytron usually with three submarginal dark spots on apical two-thirds, one or two of these sometimes almost or wholly wanting; beak, antennæ, tibiæ and tarsi dark reddish-brown. Beak slender, compressed, half as long as body, finely striate-punctate on sides, polished and almost impunctate above. Antennæ inserted just beyond basal third; second joint of funicle slender, nearly as long as the next two, the latter equal Thorax one-fourth wider than long, sides feebly converging from base to middle, then broadly rounded to near apex, which is subtubulate; disc densely and rather coarsely punctate, slightly carinate at middle. Elytra at humeri distinctly wider than thorax, thence narrowed to the conjointly rounded apex; sculpture hidden by scales. Length 3 5–3 8 mm "

DESCRIPTION OF LAST INSTAR LARVA BY A. G. BOVING

Family Characters

Larva hypognathous (with mandibles directed vertically ventrad and posterior end of cardo attached near the occipital foramen). Body subcylindrical, soft skinned, with deeply plicate segments; three thoracic and ten abdominal segments present; tenth abdominal segment small, wartshaped Legless Labrum free, movable. Mandibles without molar part. Maxilla with single large maxillary lobe; stipes behind maxillary lobe united with a large, fleshy, simple subfacial area which is continuous with prothorax. Buccal cavity without hypopharyngeal chitinization. Tentorium forming a broad and strong bridge.

Generic and Specific Characters

Head somewhat inserted into prothorax; cranium, when liberated, slightly longer than wide Epicranial suture half as long as cranium; lateral epicranial carina curved, viewed from above subparallel with outline of cranium, extending posteriorly to end of epicranial suture; each epicranial half with six setæ, arranged as shown in fig 10, 4 Ocelli two, first ocellus anterior and inferior, placed near antenna, twice as large as second, posterior and superior ocellus, the position of which is about midway between first ocellus and lateral epicranial carina (fig. 10, 2). Frons about as long as epicranial suture; frontal sutures diverging about 120°; strong median frontal carina: three small setæ on anterior frontal margin, two long and one small setæ on frontal plate, arrangement and relative size as shown (fig. 10, 4). Antennæ very small, two jointed, basal joint not much higher, but considerably wider than apical joint, with five small setæ and one sensorial puncture (fig. 10, 6). Clypeus transverse, about four times as wide as long, glabrous. Labrum transverse, anterior margin convex, extreme length medianly about as long as clypeus, width about three times greater than length; dorsal face of labrum (fig. 10, 4) on each side with three long, slender setæ; anterior marginal face (fig. 10, 1) on each side with a lateral group of three setæ and a median group of two; ventral face or epipharynx on each side with two setæ, one anterior and thick, the other posterior and fine and placed inside anterior end of epipharyngeal rod. Mandible subtriangular (fig. 10, 1) somewhat larger at base than apically; inside concave, gouge-shaped; distally with five teeth, external tooth on each side small; one small seta. Maxilla with glabrous cardo; stipes proper carrying one long seta (fig. 10, 7); palpiger with two setæ of different length; single maxillary lobe (or mala) ventrally with five well-developed setæ (fig. 10, 7), dorsally, toward buccal cavity with seven

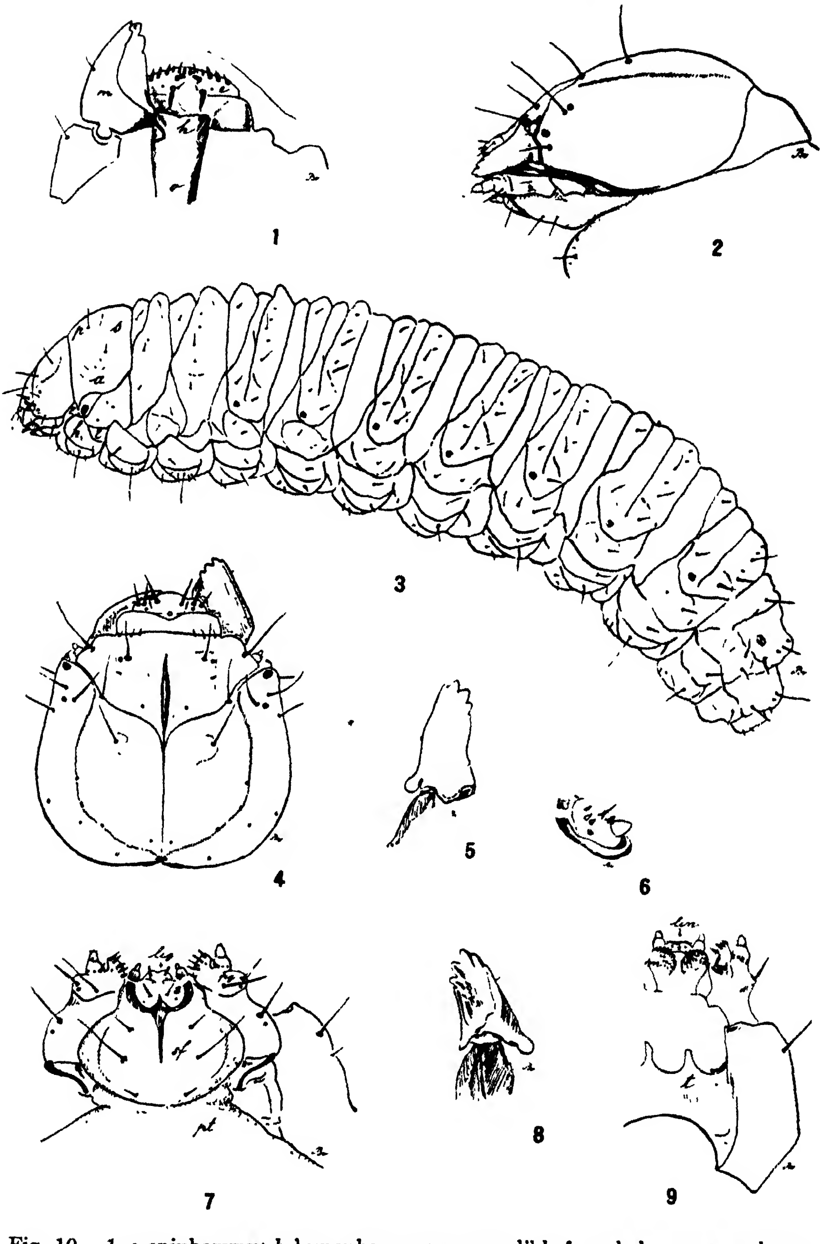

Fig. 10.—1, *e*, epipharynx; *h*, hypopharynx; *m*, mandible from below; *o*, œsophagus; 2.—lateral view of head; 3.—side view of larva; 4.—dorsal view of head; 5.—mandible, lateral, exterior face; 6.—antenna; 7.—*c*, cardo; *l*, ligula; region of fused ligula and lingua; *pg*, palpiger of maxilla; *pt*, prothoracic skin; *s*, stipes labii; *sf*, subfacial region formed by fused mentum, submentum and articulating area of maxilla; 8.—mandible, buccal, interior face; 9.—*lin*, lingua-region of fused ligula and lingua; *m*, maxillular region; *t*, tentorium.

somewhat shorter and thicker setæ (fig. 10, 9); maxillary palp short, with two articles, basal article a little longer and about twice as wide as the apical which is conical and about as long as wide; basal article with one short seta and two sensory punctures, apical article finely papillose at the tip, one sensory puncture. Stipes labii (s. fig. 10, 7) fleshy, with one seta, posteriorly limited by a curved chitinization, the posterior end of which is amalgamated medianly with an unpaired, spear-shaped longitudinal chitinization. Ligula and lingua (lig. fig. 10, 7 and lin. fig. 10, 9) fused into a short, slightly bidivided lobe; ligula region with one well-developed seta, lingua region with one minute seta. Maxillulæ (m. fig. 10, 9) lobe shaped, densely setose. The undivided subfacial area (sf. fig. 10, 7) is probably formed by a fusion of the mental, submental and the maxillary articulating areas; it carried three pairs of setæ, the position and size of which is shown in figure 10, 7.

Thorax. Prothoracic tergum simple with the different tergal areas very slightly indicated; prescutal region with one seta (p. fig. 10, 3); scuto-scutellar region with one distinct and two very small setæ (s. fig 10, 3); alar region with one seta (a fig. 10, 3). Meso-and metathorax with two tergal pleats, one formed by præscutum, and the other by scuto-scutellum and alar area; præscutum with one seta; scuto-scutellus with one distinct seta and two very small setæ below and one very small seta above this; alar area with one seta. Prothoracic epipleurum (e. fig. 10, 3) small, consisting of a triangular, glabrous preëpipleural area and a triangular glabrous postepipleural area, both above hypopleurum (h. fig. 10, 3) and separated from this area by the ventro-lateral suture; questionable if the spiracle carrying area belongs to prothorax; more probably to be interpreted as a separate part of the mesothoracic preepipleurum. Mesothoracic preëpipleurum anteriorly pushed forward into prothorax and separating the spiracle carrying area from the prothoracic postepipleurum, large triangular, with three setæ; mesothoracic postepipleurum triangular, glabrous, placed above the mesothoracic hypopleurum. Metathoracic praeëpipleurum triangular, bidivided, each division with one seta; metathoracic postepipleurum triangular, glabrous Metathoracic, rudimentary spiracle not observed in the present species. All thoracic hypopleural as well as sternal areas similar in position, shape and size. Thoracic hypopleurum situated below ventro-lateral suture, semioval, with one distinct seta; an additional very small seta on prothoracic hypopleurum. Thoracic presternum wanting in front of each thoracic segment; eusternum large, unpaired, triangular, with one seta on each side of body's middle line; parasternum or coxal lobe, representing the leg, triangular, with one large and four small setæ; sternellum wanting; poststernellum transversal, bandlike, with small median notch, glabrous.

Abdomen. The first seven abdominal segments almost identical in every respect; the three last segments somewhat modified and reduced. Abdominal tergum divided into four main pleats, corresponding to prescutum, scutum, scutellum, and postscutellum; second pleat indistinctly divided into a median dorsal part, scutum proper, and a lateral part; likewise the third pleat, divided into a median, dorsal part, scutellum proper and a lateral part; the two mentioned lateral parts are fused around the spiracle, together forming an area which corresponds to the alar area of the thoracic segments. Prescutum with one seta; scutum proper glabrous; scutellum proper with five setæ transversely arranged in proportion to the length of body, two of which are large, two small, above, and one small between the large setæ; division below scutum proper with one seta and division below scutellum proper with one; postscutellum glabrous, functioning as articulating (or intersegmental) skin. Epipleurum ventrally limited by ventro-lateral suture; median region slightly indicated, bearing two setæ; preëpipleural region subtriangular, dorsally reaching end of prescutum, glabrous; postepipleural region correspondingly shaped but not extending so far dorsally as preëpipleurum, glabrous. Hypopleurum dorsally limited by ventrolateral

suture, semioval, with one seta. Presternum wanting; eusternum unpaired, subtriangular, with posterior apex in middle line of body, two setæ on each side; parasternum or coxal lobe paired, triangular, with anterior margin oblique, inner angle pointed and meeting the corresponding angle of parasternum of the opposite side of body, one seta; sternellum wanting, possibly fused with poststernellum; poststernellum transversal, bandshaped, glabrous, functioning as articulating skin. Eighth abdominal segment somewhat smaller than the preceding typical abdominal segments, with areas less distinct, arrangement and number of setæ typical. Ninth abdominal segment half as large as eighth, areas not developed, with two large and two small dorsal setæ and one large ventral seta. Tenth abdominal segment small, wart-shaped, with terminal round anus, two small setæ. Spiracles before, small; thoracic spiracle pleural, placed right below the lower margin of prothoracic tergal region, about twice as large as the following seven abdominal spiracles, its finger-shaped air tubes directed upwards; all abdominal spiracles with air tubes directed backwards, eighth abdominal spiracle as large as the thoracic and placed slightly more dorsal than the other abdominal spiracles Size; about 9 mm. Color; whitish with light brown chitinous parts.

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Mr. W. D. Pierce: I think Mr. Ainslie is to be greatly complimented on this paper. Biologists have been puzzled many years to know how these insects lived. We have had our suspicions but no one has been able to work them up. I do not think the common name that has been given this species is sufficiently definite because there are other beetles that breed in cornstalks. It is interesting to know that this particular species extends throughout our Southern States and Central America, and probably South America.

Vice-President E. C. Cotton: The next paper is "Notes on the Habits of *Calendra pertinax* Olivier," by A. F. Satterthwait.

NOTES ON THE HABITS OF CALENDRA PERTINAX OLIVIER[1]

By A. F. Satterthwait, *Scientific Assistant, U. S. Bureau of Entomology*

One of our common and most widely distributed billbugs, *Calendra*[2] *pertinax* Oliv. (Pl. 5, fig. 2), breeding normally in the common cat-tail

[1] Published by permission of the Secretary of Agriculture.

[2] *Calendra* Clairville and Schellenberg, 1798, Ent. Helv., p. 62, takes priority over *Sphenophorus* Schönherr, 1838, Gen. et Sp. Curc., vol. 4, p. 874, according to Dr. W. D. Pierce, in Proc. Ent. Soc. Wash., vol. 21, no. 2, Feb., 1919, p. 26.

(*Typha latifolia* L.) and Calamus or sweet flag (*Acorus calamus* L.), deserves closer attention than it has had for a decade or two. Its economic prominence is based on its destruction to corn. The species was described by Olivier in 1807. During the century following, various records of heavy corn losses were connected with this name until, in 1905, Dr. F. H. Chittenden recorded the fact that one specimen that was reared about 35 years earlier had been incorrectly determined as *C. pertinax*. This specimen had been taken under circumstances which made this species appear to be the offender involved in heavy corn losses in an important agricultural area over a period of many years. With *Calendra pertinax* separated from that line of economic records, a certain distrust creeps in concerning other records, even though the determination of the insect may have been correctly made.

As for distribution, since the confusion of this insect with *C. robustus* Horn and *C. maidis* Chttn. has been eliminated, we may consider distribution summaries published by Dr. Chittenden in 1905 and by others since that date, correct, so far as known at the date of publication. Dr. Chittenden in 1905 recognized the distribution of *C. pertinax* as extending from New York City to Utah, and south as far as Washington, D. C., south of which point the typical form did not appear to have been taken. From Louisiana, Texas and Kansas, and possibly Arizona, he had a different form, for which he erected the new varietal name *australis*, and from California and Nevada, another form which he called the variety *typhæ*. Messrs. Blatchley and Leng, in "Rhynchophora of the North Eastern United States," 1914, stated that *C. pertinax* occurs in Northern Indiana, about New York City, throughout New Jersey and at Orlando, Florida, with the range from New England and Canada to Michigan and Utah, and south to Florida.

The writer has taken the species at Athens and West LaFayette, Indiana, and at Advance, Charleston, Sulphur Springs and Webster Groves, Missouri, and has been privileged to include in his studies, material from Hagerstown, Maryland, through the kindness of Mr. C. M. Packard, from Flushing, New York, through the generous coöperation of Mr. E. L. Bell throughout the season of 1919, and through the kindness of Mr. J. H. Jenkins and of Dr. J. L. Cook, of Advance, Missouri. This opportunity is taken to thank also the members of the staff, Messrs. H. R. Painter, R. A. Blanchard, C. Bagby and B. S. Reid for their valued assistance in the work, and Mr. W. R. Walton for helpful criticism of the manuscript. Taking each locality separately, we will consider first,

The Situation at Flushing, New York

While making a study of *Sphida obliqua* Walk., Mr. E. L. Bell, of Flushing, N. Y., made an incidental report on *Calendra pertinax* to

the New York Entomological Society, revealing a different mode of wintering than has been observed by the writer. Upon request for data and infested host plants, Mr. Bell responded very generously and has supplied the writer with numerous collections of stalks of the common cat-tail (*Typha latifolia* L.) at representative intervals throughout the year, with pertinent notes on water levels in relation to the plants submitted.

In his letter of April 17, 1919, Mr. Bell wrote in part as follows: "The specimens that I collected were taken this year on March 1 and 8, except one adult specimen taken on February 22, and included one larva, several pupæ in different stages, and adults. So it would seem that this species does not hibernate in adult form, but rather pupation occurs in the late fall or winter, and the adults emerge in the spring. Most of the specimens were collected in a low part of the swamp that is always flooded in the winter and spring, and at the time they were collected, their position in the stalk was at least a foot under the water, but they did not seem to be in any way harmed by it. They seemed to run somewhat to colonies, as in some places every stalk contained from one to four beetles or pupæ and in other places close by but an occasional specimen or none would be found."

Dr. S. A. Forbes, in his Eleventh Report, pages 17 and 18, stated that Dr. Kellicott repeatedly reared this species to the imago in July and August from larvæ and pupæ found in New York in the common cat-tail; and that Professor Parrot, relating to Nebraska insects, assumed that *C. pertinax* wintered over in the pupa stage, as he had received some specimens in May, 1898, some of which had the peculiar pinkish color characteristic of beetles just emerged from the pupa. This Nebraska observation appears to agree well with Mr. Bell's New York observations this spring. Dr. Kellicott's observation agrees well with Mr. Bell's observations and collections this summer, and with the writer's observations in Indiana and Missouri.

Under date of April 28, Mr. Bell wrote that they had had several days of unprecedentedly cold weather just preceding April 26, when he collected a number of cat-tail stalks which he believed contained pupæ and adults from a portion of the swamp where the water was several inches more than knee-deep, the swamp being very full of water from recent heavy rains. He examined cat-tail stalks that grew on the edge of the swamp where it was drier and found some stalks that had contained *C. pertinax*, but no billbugs were present in them.

This collection of April 26 was received April 30. There were 15 stalks in the collection, each stalk and root crown and the only piece of rhizome in the collection showing larval work. There were 25 larval excavations, 20 or 21 containing exuviæ, 2 dead larvæ, 6 dead pupæ and

4 male and 2 female *C. pertinax* adults, all dead, and one of each sex imperfect. From this collection it appears that all pupation takes place in the stalks, at least in cat-tails constantly in water, the larval excavations terminating at varying distances above the crown, as if the insect instinctively sought for a pupation place above the normal water level. Of these 25 excavations, 20 or 21 appeared completed, judging by evidences of the transformation from the larva to the pupa in all but 4 or 5. These excavations ranged above the crown as follows: 1 at 2 inches, with the adult specimen dead in a position indicating effort on its part to escape by cutting out of the plant; 5, between 3 and 4 inches; 7, between 4 and 5 inches; 3, between 5 and 6 inches; 4, between 6 and 7 inches; 2, between 7 and 8 inches; 1, at 8¾ inches; 1, at 11½ inches; 1, height not noted. Those with excavations reaching more than 7 inches above the crown all escaped successfully. These numerous dead specimens probably were drowned by the unusually high water catching them while they were immature, those dying in the adult stage being weakened by submergence while yet pupæ. During summers, the water drains away from this area and the cat-tails stand on moist soil.

On June 29, Mr. Bell collected nine stalks of cat-tail from this same swamp. They were received for study July 3. On this date 14 eggs and 18 larvæ were found and 3 feeding punctures of adults were observed. When the collection was made, June 29, the water had disappeared, though the soil remained soft and spongy.

The next collection was made in the same area August 10, at which time there was about 8 inches of water present, the result of heavy rains of the preceding three weeks. This collection was received on the 13th and examined on the 13th and 14th. There were 16 stalks. The living specimens found were 6 eggs, 14 larvæ and 4 pupæ, and the dead specimens were 2 eggs and 11 larvæ. There were several larvæ in a soft, white condition, strongly indicating that these were drowned, leading to the conclusion that the flooding of the cat-tails had been the chief cause of mortality. Six male and 5 female *C. pertinax* adults were successfully reared from this collection, 1 being adult October 6 from an egg laid prior to the collection of the stalks on August 10. The other adults issued on August 19 and September 6 and on intervening dates.

The next collection was made September 6, at the same place as previously, with the water level just where it was August 10,—almost knee-deep. He observed that almost every cat-tail stalk in this locality contained larvæ, with some stalks so full of them that there was only a thin shell left, and they broke off at the root when the attempt was made to pull them up. This collection was received September 12

and was examined the next day. There were 12 stalks, each one showing larval excavation. One adult male *C. pertinax*, 2 live pupæ and 1 living and 3 dead larvæ were secured, a small representation as compared with earlier collections, probably partly the result of the decay of the specimens which, four weeks ago, would have been visible, and partly the result of some considerable percentage of the survivors, as observed in the collection of August 10, having matured and escaped. One adult female *C. pertinax* was reared from 1 of the pupæ on September 19.

The next collection was made September 21, Mr. Bell choosing another section of the swamp which is not covered with water, though quite damp. The cat-tail growth here is not so heavy as in the portions covered, the plants standing somewhat separately in a heavy growth of various kinds of vegetation. In this soil the plants would not pull up, so were cut off somewhat below the surface of the ground. While making the collection, Mr. Bell saw larvæ, pupæ and adults of *C. pertinax* in some stalks. He searched in the soil about the plants and found no evidence of any larvæ leaving the plants to pupate in the soil. This collection was received for study September 24, and consisted of 19 stalks. Of these, 18 contained a total of 23 *C. pertinax* larval excavations, and only 1 was unaffected. In the 19, there were 4 stalks containing *Sphida obliqua* larval excavations, both insects working in common in 3, 1 of these 3 stalks containing burrows of two *Calendra* larvæ and the larvæ themselves. One *Sphida* excavation contained a pupa shell of the moth. There were also 2 prepupæ, 6 pupæ, 6 male and 1 female *C. pertinax* adults, 1 hymenopterous parasite cocoon with a *Calendra* larval mask attached in the larval excavation. In checking up as to place of pupation for the makers of these 23 larval excavations, 2 specimens were prepupæ, 6 were pupæ, 5 were adults, 9 left their exuviæ in their cells in the stalks, escaping as adults, and 1 was destroyed by a parasite while in the larval stage. Thus, the fact that pupation at Flushing occurs in the cat-tail stalks, even in those plants not in standing or flowing water, is well established. From 1 of the pupæ, an adult male *C. pertinax* issued September 26.

On October 13, Mr. Bell made a collection in the water and in the soil areas, in the same swamp as before, keeping each collection distinct for comparative study. These stalks were all cut off, rather than pulled up with crown and possible roots. In the water area there was not nearly so much water as on the occasions of the collections of August 10 and September 6. Mr. Bell observed that all the stalks he sent lacked flower stalks and always have been shorter than the uninfested stalks, except of course the young shoots. In the series of 12 stalks from the water area, there were 22 burrows, 16 dead larvæ, 2

dead pupæ, 2 hymenopterous parasite cocoons, 5 adult exit holes, and a lost top to 1 larval excavation, the top having been removed in the swamp. Of these, 10 larvæ and 1 pupa appeared to have been drowned. Thus, of 23 specimens actually accounted for,—18 dead and exits presumably of at least 5 adults,—about 8 per cent of the mortality is parasite, about 48 per cent apparently drowning, 22 per cent not accounted for, and only about 22 per cent of the brood successfully matured. So far as life permitted, pupation in this series was entirely within the plants. The series of 12 stalks from the portion of the swamp not water-covered showed 16 burrows, 3 dead larvæ (2 killed by hymenopterous parasites but none apparently by drowning), 2 living and 3 dead pupæ (1 killed by a hymenopterous parasite), 2 adult female *C. pertinax*, 3 hymenopterous parasite cocoons and exits presumably of at least 5 adults. Only 1 of the 12 stalks showed a portion of a crown. Had the complete crowns been secured, more excavations and possibly, though improbably, some evidence of soil pupation might have been found. Thus, of 15 specimens actually accounted for,—6 dead, 4 living and present, and exits presumably of at least 5 adults,—60 per cent have matured or probably will mature successfully, with 20 per cent mortality attributable to parasites and a like mortality to undetermined causes.

In conclusion to the study of the *C. pertinax* habits in the Flushing, N. Y., conditions, it may be stated that pupation has occurred invariably in the cat-tail stalk, at or near the top of the larval excavation, that adults developed in the swamp as early as September 6, and in cages as early as August 19 from a pupa collected August 10. In the collections of October 13, 1919, of 38 specimens accounted for in 24 stalks, 12 adults had matured fully and only 2 remained immature, these 2 being pupæ with a fair possibility of maturing before winter. Numerous eggs were present August 10, 1919, while pupæ were present, indicating a possibility that some might not mature before winter, hence explaining the condition that Mr. Bell found at Flushing in March, 1919, when larvæ and pupæ, as well as adults, were present. One point accomplished in the long egg-laying period of *C. pertinax* is the avoidance of the obliteration of a colony by any probable single rise of water level. Eggs laid from the middle of June to the middle of August are likely to be laid in part at every normal water level, while, in the event of the water level rising only after the last of the eggs have been deposited, those first laid at low water levels will have had time to mature and the adults escape.

The Situation in Indiana, Maryland and Missouri

The places in Indiana, Maryland and Missouri from which *C. pertinax* used in this study have been collected are West LaFayette and

Athens, Indiana, Hagerstown, Maryland, and Advance, Charleston, Clinton, Meramec Highlands, Sulphur Springs and Webster Groves, Missouri.

At West LaFayette, Indiana, a number of common cat-tails growing in a small seepage swamp on a hillside on the east side of South Ellsworth Street, and separated from the Wabash River by a half mile of cultivated bottom land, were examined on October 29, 1915. A number of stalks showed larval work, but only 1 good larva was secured. This larva, in the root crown in which it was found, was placed in a tin cage and kept in a warm room. By November 2, it had left its excavation. By November 18, it had pupated and by the 23rd, had become an adult male *C. pertinax*. Undoubtedly if this specimen had remained in the swamp, it would have wintered as an immature specimen, probably as a larva. Investigations of cat-tails in this swamp were continued November 27, when several excavations packed characteristically with frass, with occasional larval masks, were found, and 1 dead adult *C. pertinax* was found in its larval excavation, above a wad of frass representing one end of the pupal cell. The larval excavation extended some inches along the horizontal root stock or rhizome.

On July 14, 1916, the billbug situation in a field two miles northwest of West LaFayette, where possibly 10 acres of land had gone back to swamp, was made the subject of study. As the result of a neglected tile drain, water was constantly present in such quantity that water fowl bred there. Cat-tails were abundant some distance out in the water. The river bulrush (*Scirpus fluviatilis* (Torr.) Gray), was perhaps the dominant possible billbug host actually growing both in the water and on the shore. The land around the pond was covered with a dense sod, mostly of *Cyperus strigosus* L. The evidence of billbug work is frequently hardest to find where the host plant is extremely abundant. It so happened, however, that in this large bed of *C. strigosus*, 1 female *C. pertinax* adult was taken, clinging head downward as if feeding, on a plant of *C. strigosus*, about 1 inch above the roots. In her cage, this female fed freely on the plant.

About a mile east of Athens, Indiana, a collection of common cat-tail root crowns infested with *C. pertinax* was made in a mud hole along the north side of the Erie Railroad, when the mud was stiff enough to walk on. About 25 per cent of the crowns were infested, some with 2 or more larvæ to the crown. Two larvæ were nearly or quite mature, some were quite small. From this collection, 17 *C. pertinax* adults, including 5 males and 11 females were reared, mostly in an outdoor, 10-inch flower pot cage. This cage was examined October 18, at which time 13 adults, 7 pupæ and 1 diseased larva were found, some in pupa cells in the soil, and no specimen and no exuviæ belonging in pupa cells were found in any of the larval excavations in the crowns.

At Hagerstown, Maryland, Mr. C. M. Packard collected 8 larvæ boring in the bases of stems of the common cat-tail in the City Park swamp, July 25, 1919, and sent them to the writer for study. From these larvæ, 2 male and 1 female *C. pertinax* adults were reared, 1 adult issuing August 5, and 2, August 25.

At Charleston, Missouri, the collection places were beds of common cat-tail in dredged ditches at the east and west edges of town. The surface soil in the vicinity of the ditches is sandy, with sand modifying a limited part of the cat-tail areas studied, gumbo being the chief soil encountered in the ditches. The condition of the soil seemed to make no difference in the degree of infestation, or in habits, though plants constantly in water at the head of the east ditch were examined and no infestation found. Larvæ proving to be *C. pertinax* by rearings, were collected in excavations in cat-tail stalks close to crowns, in the crowns and in the rhizomes, and in the soil about the roots, and pupæ were collected in the soil about the roots, but only once in plant tissue. This exception was a pupa found in a cell in a leaf-sheath slightly over 2 inches above the crown and embracing a stem which, after 3 days' shrinkage, had a minimum diameter of 26 mm., or more than an inch. This pupa was injured and the species was not confirmed by rearing, but appears certainly to be *C. pertinax*.

The collections at Charleston may be briefly analysed by dates, as follows:—

August 13, 1918, 22 larvæ and 1 pupa, maturing 2 male and 3 female *C. pertinax* from larvæ collected in rhizomes and 2 females from conditions not specified, also 1 male *C. minimus* from larva in rhizome and 1 female *C. melanocephalus*, conditions not specified.

September 3, 8 larvæ, maturing 1 male *C. pertinax* from larva in soil and 1 male *C. minimus* from conditions not specified.

September 9, 10, 11, 13 larvæ and 8 pupæ, maturing 1 male and 1 female *C. pertinax* from larvæ in root crowns, 1 male and 2 females from larvæ in rhizomes, and 3 males and 7 females from larvæ and pupæ in soil, also 2 female *C. minimus* and 1 female *C. melanocephalus* from larvæ in soil.

September 21, 1 larva, 2 pupæ and 1 male and 1 female *C. pertinax* adults, maturing 1 male *C. pertinax* from conditions not specified.

September 23, 4 larvæ, 5 pupæ and 1 adult female *C. pertinax*, maturing 1 female *C. pertinax* from larva in rhizome, 1 female from larva in soil, and 1 male and 2 females from conditions not specified.

September 24, 1 larva, 3 pupæ and 2 adult male *C. pertinax*, maturing 1 male and 1 female *C. pertinax* from larvæ in soil.

September 28, 7 larvæ, 9 pupæ and 4 adult female *C. pertinax*, maturing 1 female *C. pertinax* from larva in root crown, 1 male and 1 female from larvæ and pupæ in soil, and 3 females from conditions not specified.

As insufficient data have been assembled for the separation of the immature forms of the several species of *Calendra*, and as 8 species, 2

of which have been bred from cat-tails and 2 from soil at the base of cat-tails, in the east ditch, the larvæ have been grouped under *C. pertinax* or under other species on circumstantial evidence, the size of the immature form being an important guide, as small *C. pertinax* larvæ have no occasion to be in the soil, and small larvæ in the cat-tail are presumed to be small *C. pertinax*. Thus, in the supposed *C. pertinax* list of 56 larvæ and 28 pupæ, 12 male and 25 female *C. pertinax*, 2 male and 2 female *C. minimus* and 2 female *C. melanocephalus* were successfully matured, fixing an accurate basis of determination for scarcely more than half of the immature collections.

At Clinton, Missouri, Mr. Painter found 1 pupa in soil about the roots of common cat-tails growing in a small bed in soft, wet mud, not water-covered, near the artificial lake in a pleasure resort west of town, October 17, 1918. This pupa changed to an adult *C. pertinax*.

At Advance, Missouri, in a recently drained peat area of about 1,200 acres, known as the "Big Field," 4 miles east of town, common cat-tails were growing abundantly May 23, 1919, and were heavily infested with *C. pertinax*. Corn was grown on this portion of the "Big Field" in 1918, but at this time was not through the ground. Numerous adults were taken in their feeding punctures in cat-tails (Pl. 5, fig. 1, and many eggs and some newly hatched larvæ were found in the leaf-sheaths. The eggs were laid in the cells of the leaf-sheath (Pl. 5, fig. 3), the cells being larger than the eggs for a considerable part of the width of the encircling sheath. Rarely, an egg was found between sheaths. As none of the eggs or larvæ collected in the Advance area were reared to maturity, no record of associated species was made, except that of 85 adults taken by Mr. J. H. Jenkins, Mr. H. R. Painter and the writer on June 4 and 9 and May 23, respectively, 83 were *C. pertinax* and 2 were *C. scoparius* Horn. (See plate 4.)

At Webster Groves, Missouri, eggs of *C. pertinax* were first found June 17, 1919, in cells in the leaf-sheaths of common cat-tails growing in a low area south of the Frisco Railway tracks, a short distance west of the depot. This area is completely free from water part of the year. On September 26, Mr. R. A. Blanchard collected 1 adult *C. pertinax* in soil under a cat-tail plant in this low area and 1 adult clinging to cat-tail roots about 1 inch below the surface of the soil in a similar area

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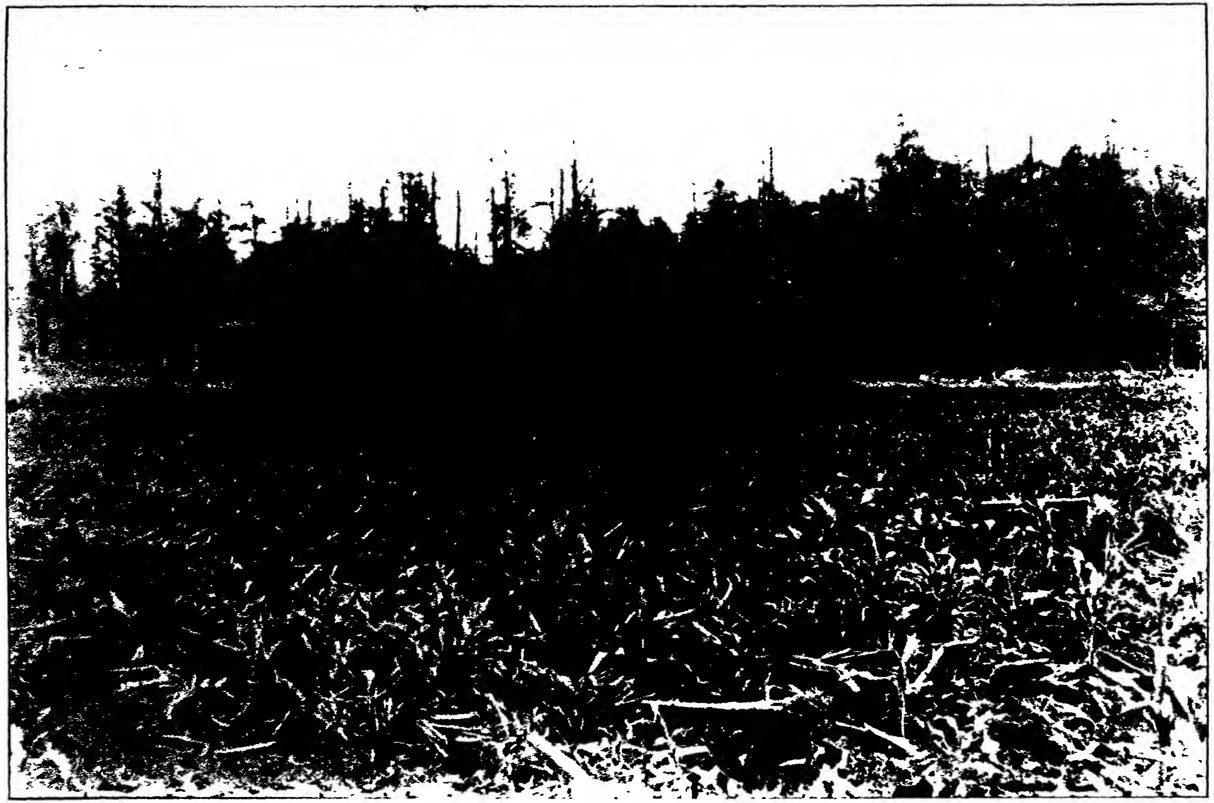
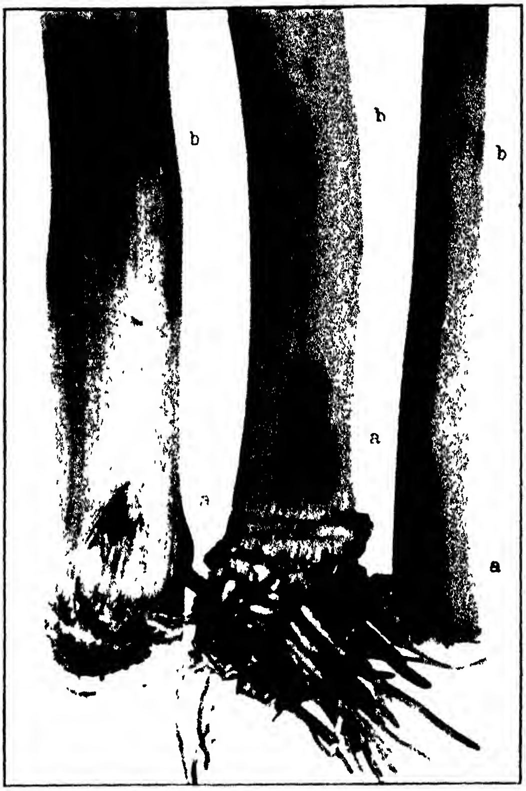
Plate 4.—A view in the "Big Field," Advance, Mo., looking northeast across damaged corn. Much damage was done to the corn by *Calendra pertinax* Oliv., the most common host plant of which is the Common Cat-tail (*Typha latifolia* L.), abundant in this part of the "Big Field." Retarded growth of the corn when 3 or 4 inches high accentuated the damage. The height of vegetation is indicated by the camera case, 14 inches high, at the right. Photographed June 9, 1919, by Mr. H. R. Painter.





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2

in Sherwood Forest, north of the railroad and about a half mile west of the first area. This latter area probably holds water throughout the year, and is being filled with cans and ashes. Both areas are in openings in oak groves, on clay soil.

At Meramec Highlands, Missouri, a few miles west of Webster Groves, on July 18, 1919, Mr. Painter collected 16 eggs and 4 larvæ, supposedly of *C. pertinax*, in common cat-tails in a small cat-tail pond in a wheat field. An adult female *C. pertinax* was reared from each of 2 eggs, the larvæ being reared in sections of corn stalks, 1 adult issuing September 27, the second, the following day. Rearings attempted in timothy were failures.

At Sulphur Springs, Missouri, the common cat-tails examined cover possibly an acre of wet, flat land a half mile west of town. A very small stream of sulphur and of magnesium spring water courses through part of it, while most of it is without a water cover during the summer. Trees margin the swamp except at the west end, where a wheat field borders the swamp at the top of a bench, 1 to 3 feet above the floor of the swamp. At first visit, July 29, 1919, the writer collected 1 *C. pertinax* pupa about 1 inch deep in the soil, 4 larvæ supposed to be *C. pertinax* in cat-tail crowns, and 1 smaller, apparently mature, larva in soil where there was no water, at edge next to the wheat field. Various cat-tail crowns were collected at the same place for subsequent study. These, examined August 7, produced 8 larvæ and 1 pupa. From the larva collected in the soil and noted as too small for *C. pertinax*, 1 adult female *C. zeæ* Walsh was reared. From the 4 supposed *C. pertinax* larvæ collected in crowns in the field, 2 adult female *C. pertinax* were matured and 1 pupa was so nearly adult that it was identifiable as a male *C. pertinax*, and from those collected in crowns subsequently examined, 6 adult *C. pertinax*, including 2 males and 2 females, were reared.

On September 16, Mr. Painter collected plants from the northern, eastern and central parts of the area, the eastern border alone being watery, a narrow stream, scarcely 1 inch deep and about 1 to 2 feet wide, flowing across. The water level at the eastern end is almost at the surface of the ground. In the western part, the water level was

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Plate 5, 1.—*a*. Feeding punctures of *Calendra pertinax* Oliv. adults in stalks of Common Cat-tail, Advance, Mo., May 23, 1919. These excavations are comparable to gnawings of small rodents, and in some instances two adults were about half buried in a single feeding puncture when found. *b*. Scars typical of egg punctures. Photographed by Mr. H. R. Painter;

2.—*Calendra pertinax* Oliv. Adult female, enlarged 6 X. Photographed by Mr. H. R. Painter.

3.—*Calendra pertinax* Oliv. eggs in situ in natural cells in leaf-sheath of the Common Cat-tail, Webster Groves, Mo. Photographed by Mr. H. R. Painter.

not within 6 inches of the surface. In the east and central part of the area, 1 mature larva was collected at the base of a plant, 1 pupa in a plant at the surface of the ground, and 2 in plants at points about 4 inches above the surface. From 1 of the last 2, 1 male *C. pertinax* was reared.

In the western part of the swamp, 3 larvæ, 3 pupæ and 1 male and 3 female *C. pertinax* adults were taken, in conditions as follows: 1 larva in base of a cat-tail plant 4 inches below the surface of the soil, which subsequently produced a female *C. pertinax* adult; 1 larva in base of plant 2 inches below the surface, which afterward produced an adult male *C. pertinax:* 1 larva in base of plant 3 inches below the surface, which died; 2 pupæ in soil 2 inches below the surface, which subsequently produced 2 adult female *C. pertinax;* 1 pupa (position not noted), which was crushed; 1 adult male *C. pertinax*, in cell, probably the pupa cell, in soil, 1 inch deep; and 3 adult female *C. pertinax* on the surface of the soil, among cat-tails.

This series shows a definite tendency to pupation in the stems, the trait appearing in 3 instances recorded above, with soil pupation in like number of instances, as observed September 16, 1919.

Viewed in their relation to water or excessively wet soil, there were the 3 examples of stem pupation and 1 of soil pupation, in the 3 pupæ and 1 prepupa taken at the east and central portion of the swamp where the stream and the water level were about at the surface of the soil. This provides a 75 per cent example of stem pupation where too much water prevails at the base of the plants, but no tendency was observed in this direction among the specimens taken where the soil was several inches above the water horizon. On July 29, at the western end, where the soil was firm, only 1 specimen was taken in so advanced a stage as a pupa, and this was in the soil, outside of its host plant.

The Economic Aspects

From the economic standpoint, the preceding notes show that the common cat-tail, a widely distributed swamp plant, is subject to liberal infestations by *Calendra pertinax*, an insect which, under favorable conditions, may prove very destructive to corn. These notes are based on 12 cat-tail areas represented by 9 post office centers, in 3 states. The writer has only one other record of cat-tail area examined, at Mt. Pocono, Pennsylvania, where a brief examination was limited to a small clump of plants rather remote from the open water. No evidence of *C. pertinax* work was found, but this negative record is not dependable. It is anticipated that all cat-tail beds are more or less infested with *C. pertinax*, and to be regarded accordingly as a menace to corn in every case where cat-tail sod is broken for corn.

The writer's first opportunity for studying the injurious work of *C. pertinax* on a large scale in the field, was in the "Big Field" area near Advance, Mo. (See plate 4.) In response to a general billbug questionaire, Mr. J. H. Jenkins, whose farm lands include several hundred acres of this recently drained, treeless tract, stated, under date of April 26, 1919, that he had a 25 per cent loss on 100 acres of Reed's Yellow Dent corn, securing only 50 bushels of corn per acre as first crop on new land which was plowed in 1917 and cropped first in 1918.

On May 23, the writer called on Mr. Jenkins, who was, at the time, unable to go to his farm. As his brother, Mr. E. B. Jenkins, had similar land and a greater billbug loss in 1918, this latter farm was visited. The field where the losses were so prominent on this farm, was particularly free from weeds, grasses and sedges, and thus without host plants for billbugs. It was stated that the condition during the corn growing season of 1918 was as now, no grasses or weeds being allowed to grow. It was further stated that this land was submerged in May, 1918, when a certain diversion canal bank gave way at the head of the drainage district as a result of an extraordinary flood. This overflow undoubtedly brought in and deposited whatever billbugs were involved in the destruction of the corn.

Mr. Jenkins stated that there were wild grasses on the J. H. Jenkins farm, some two miles north, and similar wild plants on the J. L. Cook farm lying between.

Dr. Cook's farm was visited at a point in the open area a short distance east of the tenement house which is situated in the woods. The peaty soil here is very subject to ignition from bonfires, and is of such a character that one may shake the surface for a possible radius of 50 yards. Large wooden shoes are attached to the feet of horses and mules used in the "Big Field" to keep them from sinking too deeply into the soil.

Wild iris occurred sparingly and showed no billbug infestation, but the common cat-tail was rather abundant in patches and *Calendra pertinax* adults were found on a heavy proportion of the stalks, with feeding and egg punctures in nearly all. In a little while, 15 adults and numerous egg-infested stalks were collected for study at the laboratory. The feeding holes of *C. pertinax* in cat-tail stalks are largest at the stalk surface, usually as wide as the width of the adult. They are sometimes circular and sometimes twice as long, up and down the stalk, as wide, and occasionally deep enough for more than half of the adult to be within the contour of the stalk. It is similar to the gnawing work of a small rodent. (Pl. 5, fig. 1.) The egg punctures are without excavation, a slit being cut through the outer surface of a leaf-sheath or, if deeper, through one more outer than inner surface, and

the egg deposited in a natural cell. (Pl. 5, fig. 3.) Rarely, an egg was found deposited between leaf-sheaths. Several eggs are frequently found in a single leaf, some leaves in this collection having four.

On May 29, Mr. J. H. Jenkins wrote of the "Big Field" as open marsh land, formerly covered with tall grass, some of it growing to a height of 15 feet. Of his corn, he writes: "I am having considerable trouble with my corn on this land and hardly think that the trouble is due entirely to billbugs. The corn comes up and grows to 3 or 4 inches in height, then turns yellow. Some stalks die and others finally grow out, later in the summer, but not in time to make an ear. Pumpkins and turnips, in the same locality where the corn dies, make a fine crop."

On June 4, Mr. Jenkins wrote again concerning his corn. His tenants were complaining considerably, which led him to make a personal investigation. His letter, in part, is as follows: "I find that most all of the blue flags have the billbugs, usually from one to as many as six on each plant, and I find some injury in the corn resembles the billbug injury in the flags. However, in the infested places all the corn looks bad, the leaves cut and wilted, and of a yellow color. On some of the corn plants I can find the effect of the bugs and can find some bugs on the corn plants, but on other plants that look just as bad, I cannot find any sign of the bugs. I have about 300 acres of corn planted. Of this amount, I have about 50 acres that now looks like it will be a total loss, as the corn is turning yellow and dying. I planted some over last year and the second planting did about as bad as the first planting. I have made a pretty close study of this trouble and I am impressed that there is some cause other than billbugs, such as lice, ants or gnats. I found a few chinch bugs today, however, not enough to cause any material trouble. The water level is very close to the surface, which fact makes it appear to me that, if the land was tiled, there would be less of the above named insects. I find also quite a lot of green gnats and green insects like lice, which may account for the leaves of the corn being withered and eaten as you will see from the samples I am sending you in today's mail. . . . In selecting this corn today, I pulled up all the damaged plants in the row, in order that you could see that some of the plants had the sign of the bugs and that some did not show the place of injury. I found most of the bugs I have in the sack with the corn on blue flag. However, I found some bugs on the corn plants. I found two worms that had entered the corn plants at the root and worked out all the center of the plant."

The letter, specimens of injured corn and the insects were received June 5. The billbugs collected on blue flags and corn were *C. pertinax*, 2 males and 10 females. As blue flags occur in the "Big Field," they

may have been the host plant in this case, but on May 23, the writer found no billbugs nor billbug work on the isolated blue flags then examined, while the cat-tail was very heavily infested. The two worms that had worked in the centers of two corn plants mentioned in Mr. Jenkins' letter, were referred to Mr. George G. Ainslie for determination. Under date of June 10, Mr. Ainslie reported these as *Crambus praefectellus*, a species of root web-worm usually taken singly, hence not usually a serious pest. There was 1 adult *Diabrotica 12-punctata*, but as none of its work was recognized on the corn leaves, it is probably not seriously involved. No lice, ants or gnats were found. Some of this shipment of corn plants were forwarded to Washington for pathological examination, but were spoiled before reaching their destination.

On June 2, Dr. Cook sent to the laboratory a package containing 5 corn plants. This package reached its destination June 6, broken open. No living insects remained with the corn. The partial remains of a male *C. pertinax* were found. The corn plants were crippled and showed punctures typical of *C. pertinax* adult work. The crowns also showed discoloration of the same type as did those from Mr. Jenkins.

On June 9, Mr. Painter visited the "Big Field," examining the billbug infested fields of the Messrs. Jenkins and of Dr. Cook. He agrees in his observations with Mr. J. H. Jenkins in the conclusion that there is insufficient drainage. He found the water level was within about 8 inches of the surface of the ground and the whole area practically of the same level throughout. He found cat-tails quite prominent (see Plate 4), and cane grass (probably *Arundinaria tecta* (Walt.) Muhl.), rather plentiful, in various parts of the field. *Calendra pertinax* was abundant at this time in cat-tails. In a portion of Dr. Cook's field, Mr. Painter secured 6 male and 12 female *C. pertinax* adults and, while collecting these, took 2 female *C. scoparius* adults, 1 on corn and 1 on cat-tails. While this would indicate that *C. pertinax* represented only 90 per cent of the billbug infestation, the consideration of all adults taken by Mr. Painter where corn was growing in the "Big Field" on this date, 20 male and 37 female *C. pertinax* and 2 *C. scoparius*, the fair portion of the billbug damage chargeable to *C. pertinax* would be slightly over 96 per cent.

In summing up the relationship of *C. pertinax* to the corn loss this year and accepting the statement of the gentlemen pecuniarily interested in the corn, that the conditions we saw this year were the same as prevailed last year, the writer is disposed to charge *C. pertinax* with about 95 per cent of the insect damage to the growing corn plants, and the insect damage about 90 per cent, and direct water damage in some possible depressions, 10 per cent. The close proximity of water to the surface of the soil undoubtedly is a disadvantage to corn in this

"Big Field" at times, depending on the height of the water table and upon the temperature of the soil. How much damage is due to the presence of water and how much to the billbugs must remain a matter of opinion, but the water damage appears to the writer to be essentially a halting of the growth of the corn during the higher level of the water or during the unfavorably cool weather, especially when the corn is up only 3 or 4 inches, as mentioned by Mr. Jenkins, in letter of May 29, for 1918 and 1919. Such conditions probably cause some yellowing of the foliage without killing the plant or reducing the yield. Incidental to the halt in the growth of the plant, the work of any insect will have an intensified deleterious effect, provided the conditions retarding growth in the plant do not equally retard the insect. As *C. pertinax* is a swamp grass insect, the retarding effect of water on the adult is negligible.

Referring to Mr. Jenkins' description of the corn injury, as seen June 4, we have this statement: "In the infested places all the corn looks bad, the leaves cut and wilted, and of a yellow color." Mr. Painter observed the condition of the leaves on June 9, and says the perforated appearance of leaves typically injured by billbugs was lost, and the leaves of many plants were blown to ribbons, with no apparent explanation. These observations so well represent extreme billbug injury to corn foliage as seen at Charleston, Mo., in 1917, where the damage was done by *C. callosus* Oliv. and *C. destructor* Chttn., both smaller species than *C. pertinax*, that the leaf condition is accepted as adult billbug work, 96 per cent *C. pertinax*.

Dr. Forbes, in his Eleventh Report, states that the plant injured by *C. pertinax* is less frequently killed outright than by *C. aequalis* Gyll., a larger species, but is commonly dwarfed, often becomes badly twisted as it grows, and rarely forms an ear. Mr. Jenkins, in his letter of May 29, describes this injury when he writes that "some stalks die and others finally grow out, later in the summer, but not in time to make an ear."

A report from Mr. Jenkins, received December 16, 1919, after he had studied the corn damage throughout the season and harvested the corn, includes an estimate that the billbug damage was 80 per cent of the insect damage and the major part of all the damage. He considers that the wetness of the season and of the soil caused the corn to come to a stand still, making the work of the insects more disastrous. He has already laid considerable tile, which will improve the drainage. The plant he referred to earlier as blue flag he now reports is cat-tail, on 1 plant of which he collected 8 billbugs. Some of the corn made a good yield, about 80 bushels per acre, while some was almost a failure. The area damaged in 1919 was less than in 1918, when the damage was very heavy.

In this area, improved drainage will help the corn to grow steadily and will help the land operators to destroy the billbug host plants. The breaking on this tract was done the year before the first crop was planted, which was good. Summer breaking gives the quickest results in destroying billbug host plants. If they are completely destroyed before winter, any surviving billbugs will leave, and corn can safely be planted the following spring. Where the destruction of host plants is only partial, the planting of corn will be attended with such losses that a diversity of crops not susceptible to billbug injury, such as pumpkins, turnips, melons, flax, cotton and beets, might and probably would be more profitable. Such crops planted in rows and cultivated would allow as rapid destruction of the host plants as would corn. Usually billbug injury ceases to be serious after the second crop has been produced on new land where the host plants have been abundant. These losses, however, may be eliminated completely or may cover several years, depending directly upon the time the host plants are completely destroyed.

Mr. E. G. Kelly: Have you found the larvæ of this insect in corn?

Mr. A. F. Satterthwait: No. The injury to corn that I have found was caused by the adult.

Vice-President E. C. Cotton: The next paper is "The Green Clover Worm on Soy Beans," by Franklin Sherman, Jr.

THE GREEN CLOVER WORM (PLATHYPENA SCABRA FABR.) AS A PEST ON SOY BEANS

By Franklin Sherman, *Entomologist State Department Agriculture, Raleigh, N. C.*

On July 29, 1919, the farm agent of an eastern county in North Carolina wrote us of a worm destroying leaves of soy beans. Within a week complaints were coming by the dozen. Larvæ were identified at Washington as *Plathypena scabra* Fabr. the Green Clover Worm, one of the "Snout-moths" of the family Noctuidæ (broad sense), and we were told that it had become epidemic simultaneously from New England to Florida.

Within ten days the injury was at its height, within two weeks it was on the decline and some fields were recovering,—but also in less than a week from the first complaint a preliminary survey had been made, and we had two temporary Field Stations in operation, one by the writer at Elizabeth City and the other by Mr. Leiby, assistant, at Terra Ceia.

Our special studies extended from August 1 to September 10, covering the last of one brood of larvæ, through the pupal, adult and egg stages, to the point where the next generation of larvæ were about one-fourth grown. While most of the facts here given are from the writer's own work, Mr. Leiby's notes are also used as mentioned from time to time.

The Life-stages

Our findings on the duration of the several stages agree well with the accounts of Coquillett in Canadian Entomologist July, 1881,—Chittenden in Bulletin 30 U. S. Division Entomology 1901,—Britton in 8th Report Entomologist of Connecticut 1908,—and Hill in Farmers Bulletin 982 U. S. Department Agriculture, 1918.

Eggs collected in the field hatched within 4 days,—those laid in Mr. Leiby's cages in five days.

From hatching to spinning of cocoon is given as 25 days by Coquillett, which we take to be normal in mid-summer.

We both recorded that after spinning the fragile cocoon the insect remains as a larva for two days. We have not found mention of this in the literature.

The true pupal stage varied from eight days *plus* to 14 days and a fraction,—*eleven days* being the most common and also the average, we give it as the true normal for the time and place of our observations.

From August 17 to 22, the writer placed in one cage with suitable foliage and water, reared moths as follows: six males, thirteen females, and six of undetermined sex. Only one certainly laid eggs and these eight days after the last male had been removed, dead. Mr. Leiby had similar results under same conditions, but secured eggs more freely when molasses was lightly smeared on the leaves, on which he observed both sexes to feed. He also found the moths to live a week or more before laying eggs. It seems certain that mating takes place soon after emergence and that a week must then elapse before eggs are laid, the moths feeding in the meantime.

Summary:

Egg	5 days
Hatching to spinning of cocoon	25 days (*Fide* Coq.)
Larva in cocoon	2 days
True pupal stage	11 days
Emergence to mating	1 day
Mating to laying of eggs	7 days
Total	51 days

The winter is normally passed in the adult stage, as proven by numerous collecting records in our own state and elsewhere.

HABITS

Hill, referring to outbreaks in alfalfa, says the eggs are laid on the under side of the leaves and are hard to find because their color matches the leaf. On soy bean we found the very fresh eggs to resemble the leaf, but as they approached hatching they were darker, the chief difficulty in finding them being their small size. We did not find a preference for the lower side of the leaf. In a close examination of 1,600 leaves August 27 to September 1, we found 62 eggs on upper surfaces to 45 on lower surfaces. As an evidence that the moths disperse far and wide before laying, eggs were found as numerous where the larvæ had been fewest, as where they had been most abundant.

The larvæ can spin a weak thread and young ones often suspend by it. They are active and when disturbed can contort so violently as to throw themselves several feet. As one farmer wrote—"he flops like a cat-fish." They crawl with a semi-looping motion. They are green, variable. In our cages as well as in the field very young larvæ showed a preference for the under side of the leaf and did not eat all the way through, but within three days, by the time they devoured an area as large as our copper cent, they ate entirely through and were to be found as numerously on the upper as on the lower surfaces. These observations refer to the larvæ on soy-bean, especially on the younger leaves. I am aware that others have found that on lima bean they are more prone to remain on the lower surface and to feed only on that side, leaving the upper epidermis intact.

Having observed the feeding habits both in cages and in the field we can say that even when present in great number the injury is not conspicuous for the first fifteen days of larval life, but becomes greatly emphasized during the last ten days.

When grown the larvæ drop from the plant or wander, often being found on weeds upon which they apparently did not feed. They pupate on or just under the soil in cracks, crevices, accidental holes or under trash, in loose silken cocoons mingled with particles of earth.

The adults fly actively, show an inclination to seek shelter around buildings, and are only indifferently attracted to light. The males average larger than the females, indeed the sexes were regarded as distinct species until proven identical by Lintner in Canadian Entomologist, May, 1873.

NATURAL ENEMIES

The only definite records we find under this head in the literature are in Chittenden's paper where two species of parasites are recorded, neither of which were found by us.

At Elizabeth City on August 14 the writer entered in his notes with reference to the then maturing brood of larvæ, that bacterial disease had killed many and might be a factor with the next brood; that perhaps 25 had been seen affected with fungous disease, not over two had been seen giving evidence of internal insect parasites, and that one paper-nest wasp (*Polistes* sp.) had been captured in the act of devouring a larva.

Rearings from 77 collected pupæ at Elizabeth City by the writer gave a total of 54 moths and 3 parasites. Fifty-six larvæ caged when grown or nearly so yielded 20 moths and no parasites.

At Terra Ceia Mr. Leiby secured a higher percentage of parasites from the pupæ.

When eggs began to appear rearings from these were begun and here was found the most important parasite factor at both stations. Approximately 50 per cent of the eggs turned to a dull black and yielded the egg-parasite, *Trichogramma pretiosa*, determined by Mr. Crawford at Washington.

A cage was started by the writer with 19 eggs collected in various parts of the field: 10 young larvæ hatched; two egg-shells were removed without finding larvæ, while the other seven eggs yielded 12 specimens of *T. pretiosa*.

Four cages operated by the writer contained eggs which appeared to be parasitized. These resulted as follows:

(Cage 1) 3 eggs of *P. scabra* yielded 7 specimens of *T. pretiosa*
(Cage 2) 8 eggs of *P. scabra* yielded 11 specimens of *T. pretiosa*
(Cage 3) 7 eggs of *P. scabra* yielded 12 specimens of *T. pretiosa*
(Cage 4) 1 egg of *P. scabra* yielded 3 specimens of *T. pretiosa*

The largest number of *T. pretiosa* reared from a single egg of the host was three. Mr. Leiby accomplished the same result at Terra Ceia. It is plain that the emergence of two adults of the parasite from one egg of the host is common, and that three is not rare. These findings give to *T. pretiosa* the undisputed first place among the parasites of the green clover worm on soy beans in eastern North Carolina in 1919.

The second parasite in importance was the Tachinid, *Phorocera claripennis*, of which Mr. Leiby reared 17 specimens at Terra Ceia, none being secured by the writer at Elizabeth City. It may here be noted that in our state this fly is the second most prevalent parasite of the true army-worm, which was in evidence where these studies were made.

The writer and Mr. Leiby each reared one specimen of the Tachinid, *Exorista boarmiæ*, and Mr. Leiby reared one each of *Frontina aletiæ* and *Euphorocera floridensis*. Of other flies the writer reared one of

Sarcophaga cimbicis and Mr. Leiby one of *Anthrax lateralis.* The writer also reared one hymenopteron identified by Mr. Cushman at Washington as "a *Campoplegine* apparently new species and new genus."

This gives a total of eight species, none heretofore recorded from this host so far as known to us. The list follows:

1. *Trichogramma pretiosa* Riley, a very important egg-parasite.
2. *Phorocera claripennis* Macq., moderately important.
3. *Exorista boarmiæ* Coq.
4. *Frontina aletiæ* Riley.
5. *Euphorocera floridensis* Tns.
6. *Anthrax lateralis* Say.
7. *Sarcophaga cimbicis* Tns.
8. A *Campoplegine*, probably new sp. new gen.

Field Conditions

To appreciate the economic problem presented to us, a brief description of field conditions is necessary. The outbreak was universal throughout the eastern half of the state: tens of thousands of acres of soy beans in the aggregate were so defoliated that the lace-work of dried leaf-veins gave a hazy cob-webby appearance to whole fields. In the most severe cases all foliage was eaten, but normally the attack was most severe on the younger of the grown leaves in the upper part of the plant, leaving the growing bud and the older lower leaves. This enabled many fields to make quick recovery when the worms were killed, or after they had matured. The larvæ were feeding so ravenously and growing so rapidly that every day, each hour, was important. It was a case of immediate action or a lost opportunity. Hence the cage work and field observations which have been mentioned were carried on simultaneously with field tests of remedies and publicity work.

With us the soy bean crop is grown in either or all of four ways (1) in rows to itself, (2) in rows between rows of corn, (3) broadcast in fields to itself, or (4) broadcast between rows of corn. We immediately recognized that whatever direct remedies were to be used could be more effectively applied where the crop was in rows by itself, and that to meet the other conditions would be more difficult.

Experiments with Remedies

We find no previous record of definite tests with arsenicals, these have been ignored as out of the question in field areas, and we were further hampered by the general reputation of beans for susceptibility to injury by their use. But it was evident that nothing less than an immediate application of arsenicals could save the situation. We

decided to advise dusting with dry powdered arsenate of lead one pound to eight pounds of dust lime, or liquid spraying with one pound to 25 gallons water, using machines in either case, or if necessary applying the dust by hand. This advice was sent to all county agents, and to the press through the extension service. We then set to work to prove the efficiency and safety, or otherwise, of this advice.

Among the tests was one in which a plant was dusted lightly by hand with the one to eight mixture, paying no special attention to the lower sides of the leaves; the plant was caged and ten nearly grown larvæ were placed on it. This cage was started by the writer at 6:30 a. m. August 8, the cage being carefully "floored" with white paper to facilitate finding any larvæ which might drop. By the 12th (in four days) seven of the larvæ had died; by 8:30 a. m. August 14 (in six days) eight had died with all the symptoms of poisoning, one had died of bacterial disease, while the remaining one had pupated; it emerged as a moth, female, on August 22. This indicated a killing efficiency of 80 per cent in hand applications. Mr. Leiby at Terra Ceia secured similar results in cage work. Such explicit data could not have been established in field tests because many worms were already leaving the plants to pupate. The remedy was effective.

On August 8 a vigorous row 112 feet long was dusted by hand as would be done in field practice for potato beetles. Observed for over a month it showed no injury in comparison with an untreated row alongside. The remedy was safe.

Another row was treated very heavily, using several times more than could reasonably be needed,—the injury was slight and temporary, the row was soon as good as its check. The remedy was virtually fool-proof.

We also tested it at strength of one pound to four pounds lime; one pound to two pounds lime; one pound to one pound lime; and pure arsenate alone, all these being applied by hand. All of these greater strengths gave injury, more severe as the proportion of arsenate increased.

Similar tests with dusting machines showed that with these the greater strengths could be safely used, but were not necessary. A very careful farmer whose field was under observation tried arsenate alone successfully as a test on his own account, but the application was very light. That same farmer afterwards said that the arsenate remedy was so simple, so effective, and so practical that had he appreciated it at its full worth two weeks earlier he would be five thousand dollars better off—as it was he prevented much of the loss,—he considered the clover worm on soy beans as a solved problem. Other testimony to like effect could be quoted. The remedy was practicable, it was not prohibitive either in cost nor labor of application.

Inquiries after the outbreak was over proved that those who acted promptly on the advice were well pleased, though all appreciated that their applications would have been more effective if given earlier.

Very early-maturing varieties suffered much more than the ranker-growing later varieties. The difference was so pronounced as to be important, but we will not here discuss it further.

We did not find occasion to use a contact insecticide for the young larvæ, the arsenate was effective and safe for our purpose on this crop. We did not find it necessary to use any special effort or adjustment to reach the under side of the leaves, the larvæ soon ate all the way through on the young soy bean leaves. We did not find it necessary to make a painstaking application to all the leaves, if the uppermost expanded leaves were well treated the great majority of the worms were killed; hence the application could be made rapidly, and this was essential in such a wholesale outbreak as we were dealing with. We did not find it practicable to collect the larvæ in nets or sheets, for when a plant was suddenly and violently shaken certainly not over half of them fell. Collection of the moths by nets was wholly impracticable of economic results. They were only indifferently attracted to lights, we tried lanterns and bon-fires with negative results. Bait traps were also tried without important results.

Powdered arsenate of lead at rate of one pound to eight pounds of lime was effective, it was safe to the plant, and it is practicable in large areas of soy beans, more so of course when grown in rows,—it is not too costly, it pays a good profit on its use, especially if applied before the injury reaches its maximum. We admit that this calls for *promptness* with emphasis on every letter of the word.

Possible Danger in Using the Hay

This one point remains. Would it be dangerous to use the hay after such treatment as here advised? Important as this question seemed to the writer at first, it now holds little interest. Contemplated tests were not possible.

A plot dusted August 8 showed very little evidence of the dust on September 11, and as only one-ninth of this was arsenate the possible danger seems too remote for consideration. Normal harvest was still one or two months away by which time it is a moral certainty that all material danger would have been removed. As time went on the material disappeared from the plants, the question seemed to become trivial; farmers who at first questioned took the same view, they have ignored the fact that poison was ever applied, and we have had no recent questions and have not heard of any bad results.

Mr. E. G. Kelly: I am deeply interested in this paper. In 1908, I went out to Kansas, and one of the first things I saw in an alfalfa field that had recently been cut was this green wriggly worm. I thought, from the numbers I saw on the ground after the alfalfa was removed, that a great deal of damage had been done or would be done by this species. Practically every year from that time up to the present, I have been in a lot of alfalfa fields, probably hundreds of them, and I have seen a lot of these worms; but this is the first record of devastation of which I have ever heard.

Mr. W. E. Britton. Mr. Sherman is to be congratulated on the manner in which he handled the green clover worm on large areas of soy beans. I have had no experience in controlling a similar situation. An arsenical spray is without doubt the most effective and at the same time the least expensive treatment that could be practiced under such conditions, yet I would like to point out that occasionally there are cases where contact insecticides may be of value. Particularly in small bean patches in gardens, one hesitates to apply arsenate of lead to snap or string beans just before the crop is ready to harvest. On Lima beans or other beans to be shelled, of course there is no danger. These caterpillars are susceptible to the use of nicotine, and by spraying the under surface with nicotine solution, or even with common soap and water, many of them will be killed. A large proportion of them will drop to the ground when disturbed, and a forceful spray of water from the garden hose will dislodge many of them and injure them so that they will never find their way back to the foliage.

I saw a good many garden patches in Connecticut last year where the caterpillars did not eat holes entirely through the leaves; they ate small holes from the under side leaving the upper epidermis, and you could see those shining spots on the leaves for some distance away. This form of injury was most common on Lima beans, but was also observed on common varieties of snap and shell beans. We noticed that a great many of the caterpillars of varying sizes turned yellow and appeared sickly; but we did not attempt to ascertain the cause.

Mr. Alvah Peterson: In New Jersey, this insect was very serious this year, on Lima beans particularly. It was necessary to coat the under surface of the leaf as well as the upper surface in order to secure control, because the young worms did not eat through the leaf. They fed entirely on the under surface.

Mr. F. L. Thomas: How does the insect pass the winter?

Mr. Franklin Sherman: It passes the winter as an adult moth hibernating under loose bark, sheds, buildings, and any kind of shelter it can find; it is often collected under loose bark on trees.

MR. GEORGE G. AINSLIE: That is one thing that we haven't been able to decide—how they spend the winter. Undoubtedly, moths are taken through the winter, but we have never been able to carry moths emerging late in the fall through to the next spring. Insects that went into the winter as pupæ and emerged during the winter were exposed and would remain through the latter part of the winter and late in the spring. Another thing—the moths that emerged late in the fall, we were totally unable to get eggs from. There are three or four generations a year, but those emerging in September never did mature the same season. Those emerging late in the winter produced eggs as soon as conditions were favorable in the spring.

MR. FRANKLIN SHERMAN: It is certainly well established that the adults do pass the winter. In what other stages they pass the winter I do not know. It has been suggested that the pupæ also pass the winter. That may be.

PRESIDENT W. C. O'KANE: The next paper is "The Life History of Some Kansas *Lachnosterna*," by W. P. Hayes.

THE LIFE HISTORIES OF SOME KANSAS LACHNOSTERNA[1]

By WILLIAM P. HAYES, *Assistant Entomologist, Kansas State Agricultural Experiment Station*

INTRODUCTION

The present study of the life histories of the more important species of Kansas *Lachnosterna* was begun in 1916. It is being carried out under the immediate direction of Mr. J. W. McColloch, to whom the writer's thanks are due for his kindly aid and criticism. The life history of one species, *Lachnosterna lanceolata* Say, a diurnal form has been previously published (Hayes, 1919). The data herein reported deal with observations on seven species of *Lachnosterna* found in the vicinity of Manhattan, Kans., five of which have been discussed by Davis (1916) in his notable report on the life-cycle of 18 different species. The two species considered in this paper and not dealt with by him are *L. rubiginosa* and *L. submucida*. The former, in point of numbers, ranks second among the night-flying species in the vicinity of Manhattan, and *L. submucida* ranks sixteenth.

In rearing, the eggs were obtained in small, soil cages and transferred to moist soil in salve boxes in much the same manner as described by Davis (1915, pp. 137–138). On hatching, the grubs were reared to maturity in individual salve boxes and kept in the insect cave described by McColloch (1917). Daily observations could thus be made to

[1] Contribution No. 39 from the Entomological Laboratory, Kansas State Agricultural College. This paper embodies the results of some of the investigations undertaken by the author in the prosecution of project No. 100 of the Kansas Agricultural Experiment Station.

determine the length of the prepupal stage, heretofore unrecorded, and the exact dates of pupation and transformation to the imago.

In general, it may be said that the results corroborate those of Davis in that a decided variation of length of the larval stage occurs in most of the species observed. Thus, some species have in the latitude of Kansas either a two or three-year life-cycle.

Species Concerned and Relative Abundance

The seven species under consideration are *L. crassissima* Blanch. (fig. 1a), *L. rubiginosa* Lec. (fig. 2), *L. futilis* Lec. (*gibbosa* Horn), *L. rugosa* Mels., *L. implicata* Horn, *L. vehemens* Horn, and *L. submucida* Lec., named in the order of their abundance at Manhattan.[1]

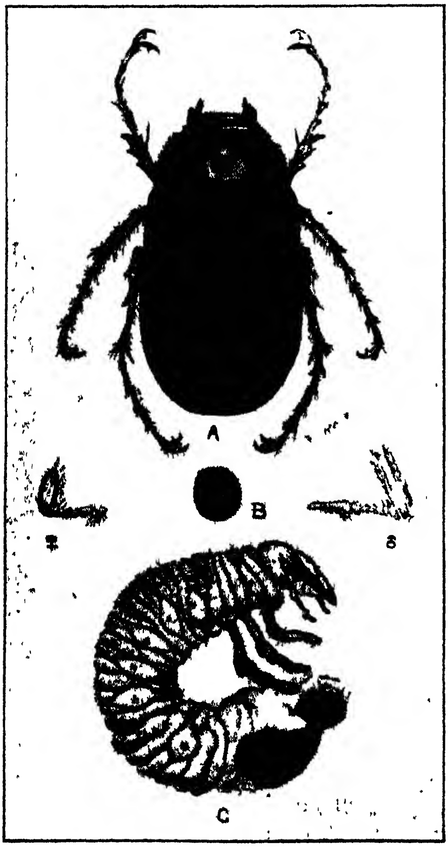

Fig. 11.—*Lachnosterna crassimana* Blanch; *A*, adult; *B*, egg; *C*, larva; antenna of female and male.

Sanders and Fracker (1916, p. 256) have shown that a remarkable variation in the distribution of the different species of this genus may occur within a distance of thirty or forty miles. The data herein given may thus be only applicable to the vicinity of Manhattan, Kans.

L. crassissima.—This species is the predominating one of the night-flyers in the area under consideration. During the past four seasons 15,655 specimens, or 32 per cent of the total collections of all species (47,494 specimens) were collected at lights, on food plants and in the soil. Over 99 per cent of these beetles have been taken at lights, although regular collections have been made on some forty species of plants.

L. rubiginosa.—Ranking second among the nocturnal *Lachnosterna* of this locality, this

[1] *L. lanceolata* is the most prevalent species in this vicinity. It is excluded from the above list and following discussion because of its diurnal habits, although its collection numbers are included in the total collections and percentages based thereon.

species comprises 13 per cent of the collections with a total of 6,191 specimens taken. The collections show that *L. rubiginosa* is more abundant on food plants than at lights, where 69 per cent of all taken were found.

L. futilis (*gibbosa*).—A total of 5,680 specimens of *L. futilis*, or 11 per cent of the total collections have been made in the last four seasons, giving to this species third place in point of numbers. In all, 4,521

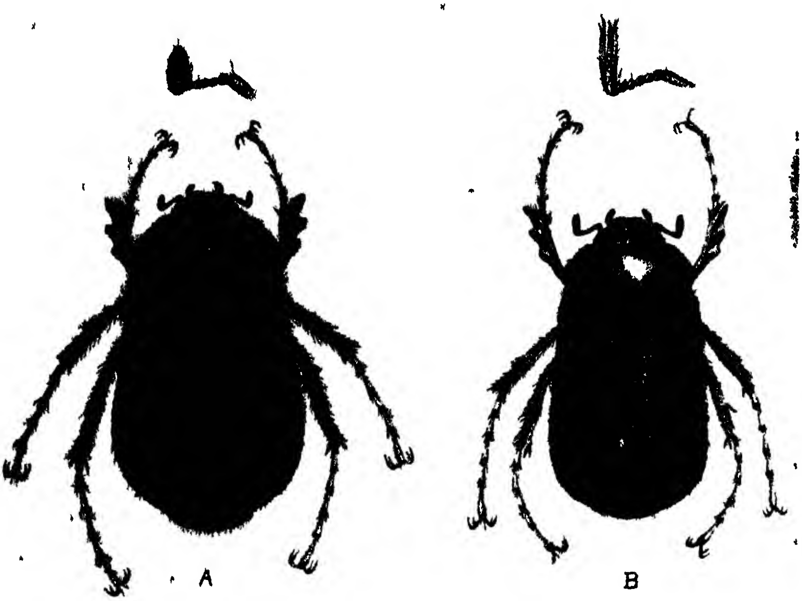

Fig. 12.—*Lachnosterna rubiginosa* Lec.; *A*, male; *B*, female.

beetles, or 79 per cent weie collected at lights, 1,150 on food plants, and five in the soil.

L. rugosa.—This species stands fourth in abundance with a total of 2,379 beetles, of which 79 per cent were taken at lights.

L. implicata.—The collections of *L. implicata* amount to 827 individuals which places the species fifth in importance. The majority, or 68 per cent, were taken on food plants.

L. vehemens.—Two other species of Kansas *Lachnosterna* (*L. hirticula* and *L. bipartita*) not considered in this paper stand, in point of numbers, ahead of *L. vehemens* which ranks eighth with a total of 437 specimens collected. Of these 429 were taken at lights.

L. submucida.—Among the 23 species of *Lachnosterna* collected in the area under consideration, *L. submucida* ranks sixteenth. It is represented by only 18 specimens, but one of which was taken on food

plants. The following biological observations on the species were made possible by the collection of a number of eggs in 1917 which, when reared to maturity, proved to be those of *L. submucida.*

Table I gives a comparison of the numbers collected during the past four seasons. An attempt was made to make the collections uniform by collecting nightly from the opening to the close of the season of flight. During the 1916 season, tree and food plant collections were neglected for light collections and in 1919 the reverse was true, light collections being neglected for food plants, so on the whole, the collecting is thought to be somewhat uniform for the four years.

TABLE I.—SUMMARY OF TOTAL COLLECTIONS

Species	1916 Brood C	1917 Brood A	1918 Brood B	1919 Brood C	Total
L. crassissima	3,412	10,244	856	1,143	15,655
L. rubiginosa	104	5,176	802	109	6,191
L. futilis	1,192	3,217	381	890	5,680
L. rugosa	571	1,301	188	319	2,379
L. implicata	395	214	131	87	827
L. vehemens	77	341	11	8	437
L. submucida	11	4	1	2	18
					31,187

LIFE HISTORY

Adults

Period of Flight.—The flight season begins as early as April 18 in the vicinity of Manhattan, and with the species concerned may last until the middle of August. The maximum period of flight occurs in May and June, except in the case of *L. submucida,* which is a late flying species that pupates in June and July and flies soon after becoming adult. It does not pass the winter in the adult stage as do the other species. In general, it can be said that *L. futilis, L. rubiginosa,* and *L. vehemens* appear first with *L. crassissima* and *L. rugosa* soon following. Specimens of *L. implicata* have not been taken before May 6, and *L. submucida* does not fly until July. Table II shows the earliest and latest dates on which the species have been found either at lights or food plants.

TABLE II.—PERIOD OF FLIGHT

Species	Earliest collection	Last collection	Period of flight. Days
L. futilis	April 18	July 21	94
L. rubiginosa	April 18	Aug. 8	112
L. vehemens	April 18	June 23	66
L. crassissima	April 22	Aug. 17	117
L. rugosa	April 23	July 12	80
L. implicata	May 6	July 21	76
L. submucida	July 7	Aug. 17	41

Proportion of Sexes.—The sexes of *Lachnosterna* are commonly known to differ somewhat in their habits of flight. It is generally stated that males are more abundant at lights and females more numerous on food plants. Males of the seven species under consideration with the exception of *L. implicata*, have been found more plentiful at lights. In the case of *L. implicata*, it is to be noted that males are proportionately rare and not found to any extent in any situation. Table III shows the proportions of sexes of the seven species collected during the 1917–1918 seasons, and of all reared individuals.

In sex ratios, the collections on food plants show different relations in the different species. More males were found than females of *L. crassissima*, *L. futilis*, *L. rugosa* and *L. vehemens*, while *L. rubiginosa* and *L. implicata* females were the more numerous.

Two noticeable points are brought out by the table. It can be seen that *L. crassissima* is represented on food plants by less than one per cent of the total collections, while 71 per cent of *L. rubiginosa* beetles were collected on food plants. Although the most abundant, the absence of *L. crassissima* on food plants indicates a preference for some food which has not yet been found. Schwarz (1891, p. 241) states that adults of *L. crassissima* probably feed on grass or low herbage.

Eggs

The eggs (fig. 11, b) are white in color and when freshly laid are oval in shape, varying slightly in size with the different species. The eggs of *L. futilis* are somewhat smaller than those of the other six species, with an average measurement of 1.7 mm. in length and 1.2 mm. in width, while *L. rugosa* eggs, when freshly laid, are about 2.6 mm. long and 1.8 mm. wide. An enlargement, accompanied by a slight increase in weight, occurs as development proceeds, causing the eggs to assume a more globular appearance. Daily measurements of the eggs show a gradual increase in size during the earlier periods of development until both dimensions have increased about .5 to .7 mm.

Table IV gives a summary of the length of the egg stage of the seven species during four seasons under observation.

The *L. submucida* eggs were collected in a field soon after laying and represent a somewhat longer period of development than is given in the table. The maximum length of egg stage varies from 20 to 38 days with the various species, and the minimum ranges from 9 to 19 days. General averages of the seven species range from 14 plus in *L. submucida* to 20.8 days in *L. futilis*.

The preoviposition period was determined in the case of *L. crassissima* at about 12 days. The number of eggs laid by an individual female is reported by Davis (1916, p. 263) as from 50 to 100. In no

TABLE III.—SUMMARY OF PROPORTION OF SEXES

	L. crassissima			L. rubiginosa			L. futilis			L. rugosa			L. implicata			L. vehemens			L. submucida		
	♀	♂	Total	♀	♂	Total	♀	♂	Total	♀	♂	Total	♀	♂	Total	♀	♂	Total	♀	♂	Total
Collected at Lights	2,510	9,592	12,102	462	1,265	1,727	326	3,028	3,354	414	920	1,334	51	3	54	52	300	352	0	4	4
Collected on Food Plants	41	53	94	2,217	2,096	4,313	488	643	1,131	192	264	456	353	23	376	1	7	8	1	0	1
Collected in Soil	20	29	49	18	29	47	3	0	3	6	13	19	2	0	2	0	0	0	2	1	3
Reared from Collected Grubs	51	49	100	29	19	48				24	29	53	14	0	14	0	0	0	1	1	2
Reared from Egg	40	38	78	14	15	29	7	9	16	9	12	21	19	3	22	1	0	1	5	8	13

TABLE IV.—LENGTH OF EGG STAGE

Species	1916				1917				1918				1919				Total			
	No. of eggs	Max. days	Min days	Aver. days	No. of eggs	Max. days	Min. days	Aver. days	No of eggs	Max. days	Min. days	Aver days	No of eggs	Max. days	Min. days	Aver. days	No. of eggs	Max. days	Min. days	Aver. days
L. crassissima	466	26	9	18 2	126	21	11	13 9	77	19	9	14 1	159	20	13	15.6	828	26	9	15.4
L. rubiginosa	42	18	14	16 3	269	21	9	12 3	110	24	11	17	13	21	12	17 9	434	24	9	15.8
L. rugosa	42	24	9	15.6	60	29	9	14.9	2	18	11	14 5	73	22	14	18 6	177	29	9	15.9
L. implicata	28	31	11	24 5	16	21	13	17 2	86	20	11	17 6	65	20	13	16.3	195	31	11	18 9
L. futilis	110	31	16	23	145	38	18	24 5	33	19	11	15.4	610	30	14	20.1	888	38	11	20.8
L. vehemens					2	28	19	23 5									2	28	19	23.5
L. submucida					83	20+	13+	14 +									83	20+	13+	14.+

instance, in the present study were more than 46 eggs laid by any female in laboratory cages. They are deposited singly in the soil and surrounded by a small earthern ball which is held in shape by a secretion from the female. The earliest date on which eggs were found in the cages was May 22. In most instances, the first species to oviposit has been *L. futilis* and it has been observed to continue egg laying until July 12.

During three seasons of the four under discussion, eggs of *L. futilis* have been the first to hatch at dates ranging from June 18 to June 27. The exception was in 1918 when eggs of *L. crassissima* were the first to hatch at a somewhat earlier date, June 10.

Larvæ

The larvæ, or grubs (fig. 11,c), of this genus are adequately described by Davis (1916, p. 265) as "white or cream white, the dark contents of the intestinal tract being plainly visible through the skin of the last few abdominal segments. The head is light tan in color, smooth and shiny and the body is covered with reddish brown hairs, those on the dorsum of the folds or ridges being short and more thickly placed. The ventral surface of the anal segment, which shows the most prominent character, bears a triangular patch of brownish hairs which are hooked at the tip, with an intermixing, especially at the borders of the patch, of fine, long hairs, and with a median longitudinal double row of coarse hairs or spines inclined more or less inwardly. These rows may be straight and parallel or more or less curved; short or long; and the spines in the rows may be sparsely or closely placed according to species. The anal slit is in the form of an obtuse angle." The young larva, when freshly hatched, is pure white, but the head soon assumes the characteristic brownish tinge.

Davis (1916, p. 262) and others have shown that latitude bears an important influence on the life-cycle of species of this genus. The farther northward a species is found the longer is the life-cycle. Smyth (1916, p. 47) in Porto Rico reared *Lachnosterna* from egg to adult in 324 days—less than one year—while Davis states that in northern Wisconsin four years are required to complete development. Davis has likewise shown, and the present data confirm his observations, that a difference of one season may occur in the time of development of grubs of the same species. This difference is due to variation in the length of the larval stage. In Table V, the larval periods from time of hatching to the attainment of the prepupal condition of some 230 individuals are considered.

The species under consideration all pupate in the fall and pass the winter as adults, except *L. submucida*, which transforms in the spring.

TABLE V.—LENGTH OF LARVAL STAGE FROM HATCHING TO PREPUPA

Species	Two-year grubs				Three-year grubs				Totals			
	No of grubs	Max days	Min days	Aver days	No. of grubs	Max days	Min days	Aver days	No of grubs	Max. days	Min days	Aver. days
L. crassissima. . .	71	459	406	423 4	35	823	732	752 8	106	.823	406	598 4
L rubiginosa . .	4	497	402	454 5	43	798	742	770 8	47	798	402	686 1
L. futilis	18	424	389	408 2	1	773	773	773	19	773	389	466 1
L. rugosa . . .	5	412	399	406 2	17	778	750	758 8	22	778	399	582 5
L. implicata . .	21	429	393	404 3	1	743	743	743	22	743	393	421 9
L. vehemens. . .					1	770	770	770	1	770	770	770
L. submucida .	13	687	658	668 6					13	687	658	668 6

TABLE VI —LENGTH OF THE PREPUPAL STAGE

Species	1916 Generation				1917 Generation				1918 Generation				From collected grubs				Totals			
	No. of pre-pupæ	Max. days	Min. days	Aver. days	No. of pre-pupæ	Max. days	Min. days	Aver. days	No of pre-pupæ	Max. days	Min. days	Aver days	No of pre-pupæ	Max days	Min days	Aver. days	No. of pre-pupæ	Max. days	Min days	Aver. days
L. crassissima. . . .	65	19	7	12.1	28	10	3	7 8					76	12	3	7 3	169	19	3	9.
L. rubiginosa. . . .	5	9	4	7.2	32	11	3	7.1					28	11	3	5.7	65	11	3	6 6
L. futilis.	15	9	5	7.1	2	8	7	7 5									17	9	5	7 3
L. rugosa	5	9	3	6.2	16	30	6	12 3					46	15	4	8 3	67	30	3	8 9
L. implicata.	20	11	3	7 8					2	11	6	8 5	10	10	4	7	32	11	3	7 7
L. vehemens.					1	7	7	7									1	7	7	7.
L. submucida. . .					13	11	5	7 9					1	6	6	6	14	11	5	6.9

This difference in time of pupation produces a longer larval period in such species than in the normal forms. Perusal of Table V shows that the maximum length of the period in two-year grubs was 497 days (*L. rubiginosa*) and the minimum period 393 days (*L. implicata*) with averages for the different species ranging from 404 to 454 days. In the case of *L. submucida* (all two-year grubs), 687 days was the maximum and 658 days the minimum period of development with an average of 668.6 days, giving differences between the averages ranging from 214 to 264 days. In other words, from seven to eight months longer are necessary for larval development in two-year species of this type.

The three-year grubs pass through two winters and pupate the second season. A maximum period of 823 days was required for development in the case of *L. crassissima*, and a minimum of 732 days with averages for the different species varying from 743 to 773 days. A difference of 339 days is noted between the minimum larval stages of the two and three-year grubs.

From the data at hand, there appears to be an alternation in the appearance of the two and three-year grubs; *e. g.*, among the generation of *L. crassissima* hatching in 1916, 85 grubs were reared. Of these, 71 were two-year grubs and 5 were three-year grubs. The generation hatching in 1917 produced only three-year grubs. This difference in the case of *L. rubiginosa* was not so marked. In the case of *L. rugosa*, only two-year grubs were raised from the 1916 brood and the 1917 brood produced only three-year grubs. Field collections made during the time of this study indicate a close correspondence to the broods A, B, and C, described by Davis (1918, p. 16) with 1917 as the time of appearance of brood A; 1918 brood B, and 1919 brood C. The alternation in the appearance of the two and three-year grubs in rearing cages, if true in nature, may be a contributing factor to the explanation of variations in size of the minor broods B and C, as for example, brood C is generally considered to be smaller than B. The 1916 brood C at Manhattan was on the whole much larger than the 1918 brood B, and may be due to the variation in time of appearance of the greater number of two and three-year grubs.

The Prepupæ

The prepupal stage begins near the close of larval development when the grub sheds its meconium and assumes a quiescent stage preparatory to pupation. This stage was found to vary from 3 to 30 days with averages for the different species varying from 6.9 to 9 days. The maximum, minimum and average prepupal periods for the seven species are shown in Table VI.

Table VII.—Summary of Length of Larval and Prepupal Stages Combined

Species	Maximum days		Minimum days		Average days	
	Two-year grubs	Three-year grubs	Two-year grubs	Three-year grubs	Two-year grubs	Three-year grubs
L. crassissima	478	842	409	735	432 4	761 8
L. rubiginosa..	508	809	405	745	461 1	777 4
L futilis	433	782	394	778	415 5	780 3
L. rugosa	442	808	402	753	415 1	767 7
L implicata	440	754	396	746	412	750 7
L vehemens		777		777		777.
L submucida	698		663		675 5	

Table VIII —Length of Pupal Stage

Species	1916 Generation				1917 Generation				1918 Generation				From collected grubs				Totals			
	No of pupæ	Max. days	Min days	Aver. days	No of pupæ	Max days	Min days	Aver days	No of pupæ	Max. days	Min days	Aver days	No of pupæ	Max. days	Min. days	Aver. days	No. of pupæ	Max. days	Min. days	Aver. days
L. crassissima....	56	58	16	37 4	22	27	25	25 8					100	49	19	28 3	178	58	16	30.5
L. rubiginosa....	3	30	24	27 6	26	35	25	27 7					48	35	22	28.	77	35	22	27.7
L. rugosa	5	50	28	32 2	16	34	26	29 7					53	36	25	29 1	74	50	25	30.3
L. implicata....	20	28	20	24 4					2	23	13	18	14	28	21	24.4	36	28	13	22.2
L. futilis........	14	33	27	28 4	2	24	23	23 5									16	33	23	25.9
L. vehemens.....					1	23	23	23									1	23	23	23.
L. submucida....					13	29	19	24 8					2	19	19	19.	15	29	19	21.9

A combination of the maximum, minimum, and average periods of the larval and prepupal stages representing the complete larval stage is shown in Table VII.

Among the two-year grubs, the combined maximum of the two stages was greatest in the case of *L. rubiginosa* with a period of 508 days, excepting *L. submucida* which required 698 days, and the minimum was 394 days. The minimum for *L. submucida* was 663 days with an average of 675.5 days. The averages of the other two-year species vary from 411.7 to 461.1 days.

The three-year grubs averaged from 761.8 to 780.3 days, with a maximum of 842 days and a minimum of 735 days in *L. crassissima.*

Ecdysis occurs twice before the pupal molt. As observed, the two molts previous to pupation in the two-year grubs occur, as a rule, during the same season that the egg is hatched, but rarely the second molt may be delayed until the following summer. Among the three-year grubs, one molt occurs during the season the egg is hatched, and the second occurs the following year. To illustrate: two-year grubs hatching in 1916 molted twice in 1916 as a general rule, but in a few instances the second molt was delayed until 1917. The three-year species hatching in 1917 molted once during the summer of 1917 and once in 1918. All of the grubs molt at pupation, and generally the pupa lies within the cast-off exuvium.

Pupæ

Besides the data obtained on a large number of reared individuals, the records on the length of the pupal stage are augmented by the addition of records of a somewhat larger number of specimens reared from grubs collected in nature. In general, no striking difference is to be noted between the periods of development of those reared and those collected, except in the case of specimens of *L. crassissima* reared from the 1916 brood in which the general average of 37.4 days for 56 pupæ was much higher than averages of other seasons or species.

Table VIII shows a comparison of the time of development in the seven species reared since 1916.

From the table, it can be noticed that the longest period of development occurred in the 1916 brood of *L. crassissima* where a single individual required 58 days to mature and in the same brood a minimum period of 16 days was required. The averages of the different species vary from 21.9 days in the case of *L. submucida* to 30.5 days in *L. crassissima.*

Length of Life Cycle

L. crassissima.—Of 106 individuals reared through the larval stage, 71 were the so-called two-year grubs and 35 three-year forms. The

egg period was found to average 15.4 days. The two-year larval and prepupal stages averaged 432.4 days and in the three-year larvæ 761.8 days. The pupal stage of 106 individuals averaged 30.5 days. Combining the averages of the egg, complete larval, and pupal stages, an average period is obtained in this species of 478.3 days in the two-year forms, and an average of 807.7 days for the three-year individuals was required from egg to adult.

L. rubiginosa.—Forty-seven beetles of this species were reared from egg to adult. Four of them were two-year and 43 three-year grubs. The average egg period was 15.8 days. The complete larval stage averaged 432.4 days, and 761.8 days in the two and three-year beetles, respectively. The average pupal period of 77 pupæ was 27.7 days. Combining these figures, averages are obtained of 475.9 days for the two-year and 805.3 days for the three-year individuals.

L. futilis.—One three-year grub and 18 two-year grubs of this species were reared. The average egg period was 20.8 days, the combined larval stage averaged 415.5 days for the two-year, and 780.3 days for the three-year grubs, and the pupal average was 25.9 days. Averages of 462.2 days and 827 days are obtained for the different periods of growth by adding the above figures.

L. rugosa.—The egg stage of this species averaged 15.9 days, the two complete larval periods 415.1 and 767.7 days, and the pupal average 30.3 days. For five two-year beetles an average of 461.3 days and for 17 three-year adults an average of 813.9 days were required to complete development.

L. implicata.—The combined averages of this species show a two-year life cycle of 452.8 days and a three-year cycle of 791.8 days. The averages of the stages were computed as follows: egg 18.9 days, larva 411.7 and 750.7 days, and pupa 22.2 days.

L. vehemens.—One specimen reared from egg to adult required 845 days to mature.

L. submucida.—This species was reared in two years and grubs of the same brood are now passing the winter indicating also a three-year cycle. The egg stage averaged something over 14 days, the complete larval stage 675.5 days and the pupal 21.9, giving a two-year cycle of slightly over 711 days as the average of 13 individuals.

Food Plants

ADULT.—Regular nightly collections on certain designated food plants have been made throughout the flight seasons of the adult beetles during the past four seasons to determine, if possible, the preferred food of the adults. Table IX shows the different food plants upon which the various species were collected.

TABLE IX.—LIST OF FOOD PLANTS

L. rugosa	*L. futilis*	*L. rubiginosa*	*L. crassissima*	*L. implicata*	*L. vehemens*	*L. submucida*
Willow	Hackberry	Hawthorn	Strawberry	Willow	Hawthorn	Bluestem grass
Locust	Hawthorn	Horse-chestnut	Elm	Apple	Horse-chestnut	
Hawthorn	Horse-chestnut	Locust	Oak	Silver poplar	Hackberry	
Hackberry	Linden	Hackberry	Catalpa	Cottonwood	Plum	
Silver poplar	Elm	Oak	Apple	Locust	Ash	
Birch	Locust	Elm	Linden	Hackberry		
Box elder	Birch	Coffee tree	Locust	Linden		
Oak	Cherry	Linden	Birch	Elm		
Cottonwood	Norway maple	Birch	Hackberry	Hawthorn		
Coffee tree	Spirea	Norway maple	Dock	Redbud		
Horse-chestnut	Coffee tree	Redbud	Hawthorn	Horse-chestnut		
Cherry	Oak	Tulip tree	Box elder	Cherry		
Plum	Box elder	Box elder	Horse-chestnut	Dock		
Norway maple	Ash	Ash	Ash	Privet		
Peach	Plum	Apricot	Cottonwood			
Persimmon	Rose	Cherry	Œnothera			
Pear	Mulberry	Peach	Amorpha canescens			
Elm	Silver poplar	Persimmon	Specularia perfoliata			
Redbud	Sumac	Strawberry	Pepper grass			
Strawberry	Catalpa	Silver poplar	Sumac			
Ash	Apple	Tamarack	Ironweed			
Spirea	Privet	Privet	Tamarack			
Apple	Tamarack	Catalpa				
Linden	Chinese sand-plum	Hickory				
Catalpa	Tulip tree					
Privet	Raspberry					
Dock	Peach					
Chinese sand-plum	Cottonwood					
Tamarack	Siberian pea					
Radish	Blue grass					
Sunflower	Dock					
Pepper grass	Orchard grass					
Thistle	Wild rose					
Raspberry						
Petunia						

Grub.—The grubs were reared in the life history cages throughout their period of growth on grains of wheat which were replaced weekly in the warmer months and entirely removed during the winter. The frequent change of food was necessary because of the development of fungi and as a result, until the grain germinated, no roots were available. The larger grubs would often consume the grain before germination.

The records in this study show the following food plant locations of the different species, based on the rearing to adults of grubs collected in the fields.

L. crassissima.—Three situations have yielded the largest number of this species. Thirty-one per cent of all reared have been taken in corn fields, 25 per cent in bluegrass sod, and 17 per cent in garden tracts where a variety of food was available. This species has also been reared from grubs collected in pastures, oat fields, strawberry beds, crab grass roots, a rhubarb bed, sunflower roots and bindweed roots.

L. futilis.—No grubs of this species have been reared from any of the collecting regions around Manhattan, despite the prevalence of the adults.

L. rubiginosa.—Twenty-nine per cent of the grubs of this species which matured were from corn, 21 per cent from bluegrass, and 17 per cent from garden tracts. Other places where the grubs were found consist of pastures, oat fields, strawberry beds, rhubarb beds, sunflower roots and potato patches.

L. rugosa.—The most striking food preference of any of the grubs was exhibited by this species where 41 per cent of all reared were taken from land devoted to gardening. Twenty per cent were taken in corn ground, and five per cent in bluegrass sod. Sorghum, wheat, and oat fields, strawberry and rhubarb beds, sunflower roots, potato patches, petunia roots and ironweed roots have yielded grubs of this species.

L. implicata.—This species has been found in corn, wheat and oat fields.

L. submucida.—This species has been found only at the roots of bluestem pasture grasses. The eggs from which this species were reared were found at the roots of ironweed which may be a preferred food plant of the grubs.

L. vehemens.—No data concerning the food preference of *L. vehemens* grubs are at hand.

Natural Enemies

Davis (1919) has recently published a comprehensive monograph of the natural enemies of this genus and little need be said here concerning them, except to enumerate the enemies encountered during these studies.

Enemies of the Grubs.—In the vicinity of Manhattan, three of the four species of *Tiphia* commonly parasitic on grubs have been found. The most important species is *T. punctata* Rob. The others, *T. transversa* Say and *T. inornata* occur rarely and *T. vulgaris* although recorded by Davis as occurring in Kansas has not been taken during this study. Among the banded digger-wasps, *Ellis 5-cincta* Fabr., and *E. interrupta* Say are rather common in this region. The Tachinid *Microphthalma disjuncta* Wied. (determined by Aldrich) has also been reared.

Hairworms of the family *Mermethidæ* have been frequently reared from grubs. Nematodes, probably *Diplogaster ærivora* Cobb, killed many grubs in rearing cages during the summer of 1919. They were also especially abundant in a collection of grubs, those of which survived proved to be *L. lanceolata.* Attempts were made without success to inoculate grubs from cultures of the nematodes. Mites, fungi and bacterial diseases have likewise proved obnoxious in rearing cages. Asilid larvæ have frequently been observed attacking grubs. So far, none of these have been reared to maturity. Toads, birds, and moles have been noted feeding on grubs.

Enemies of the Adults.—Two dipterous parasites, *Pyrgota valida* Harris, and *Cryptomeigenia theutis* Walk. are apparently the most active enemies of May beetles in this region. In this work, *C. theutis*. has been reared from *L. futilis, L. implicata, L. rugosa, L. crassissima,* and *L. crenulata;* and *P. valida* from *L. crassissima, L. implicata, L. rugosa, L. rubiginosa,* and *L. bipartita.* Another enemy, *Eutrixa exile* Coq., was reared from *L. rubiginosa.* Miscellaneous enemies, such as mites, toads, cats, birds and spiders have been noted. Two carabid beetles, *Scarites substriatus* Hald., and *Pasimachus* probably *punctulatus* Hald., were observed attacking adults. In the case of the former, two adults were noted chasing and biting at the legs of June bugs under an electric light.

Summary

The life histories of seven species of *Lachnosterna* found in the vicinity of Manhattan, Kansas, are herein considered. Five of these, *L. crassissima, L. rubiginosa, L. futilis, L. rugosa,* and *L. implicata,* in the order named are the most abundant in this locality. The other two, *L. vehemens* and *L. submucida* ranked eighth and sixteenth, respectively. Their flight periods begin about April 18 and may last as in the case of *L. submucida* until Aug. 17.

The egg stages were found to average from slightly over 14 days to 29.8 days. The larval period varied, two and three-year life cycles occurring for the five important species. Only a three-year cycle was observed in the case of *L. vehemens* and grubs now living in rearing

cages indicate a three-year cycle for *L. submucida* besides the two-year cycle discussed.

The prepupal stage averaged from 6.6 days to 9 days for the different species, and the mean pupal stage varied from 21.9 days to 30.5 days.

The averages of the two and three-year life cycles for the different species were 478.3 days and 807.7 days for *L. crassissima*, 475.9 days and 805.3 days for *L. rubiginosa*, 462 days and 827 days for *L. futilis*, 461.3 and 813.9 days for *L. rugosa*, 411.7 and 750.7 days for *L. implicata*, and 845 days for *L. vehemens*. *L. submucida* pupates in the spring instead of the fall, and thus a two-year cycle is produced which nearly equals the period of development of the three-year individuals. The average period for the species was slightly over 711 days.

A list of food plants of the adults, and situations apparently preferable to the grubs are given as is also a list of natural enemies found or reared during this study.

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President W. C. O'Kane: The next is "The Chinch Bug in Montana," by J. R. Parker.

THE CHINCH BUG IN MONTANA

By J. R. Parker, *Bozeman, Montana*

What is believed to be the first record of the occurrence of the chinch bug (*Blissus leucopterus* Say) in Montana was obtained in 1911 when on May 23 a number of fourth instar chinch bugs were sent in from Glasgow, which is in the Missouri River Valley in the northeastern part of the state. Our observations concerning the chinch bug have been very interesting to us, not only because they concerned an insect

of great economic importance hitherto not known to occur in Montana, but because its life history differed so strikingly from that reported by workers in other states.

Notes on Seasonal History

The most surprising feature about the chinch bug in Montana concerns its seasonal history. According to Webster[1] and other workers, the chinch bug hibernates only as an adult and even in the more southern states, where there are two broods, the majority of the first generation do not reach maturity until July. Finding fourth instar nymphs as early as May 23, therefore, immediately led us to believe that the insects might have hibernated as nymphs rather than as adults. The farmer who sent in the chinch bugs stated that he first noticed them about April 15, when they appeared to be the same size as those sent to the Station on May 23, *i. e.*, fourth instar nymphs. Nymphs placed upon oats in the insectary at Bozeman transformed to adults on June 12. Pairing was observed in the rearing cage throughout the month of July and August, but no eggs were seen until August 20. On September 1 about one-third of the adults were still alive, but as yet no young had been seen. On October 5 all the adults were dead, but in the cage were a number of dead and a few living chinch bugs in the first and second instars. None of these survived the winter.

On June 26–30 of the same year, the writer visited the Glasgow district and found chinch bugs very abundant in prairie grass and in much smaller numbers in cultivated crops. The nymphs by this time had all transformed to adults, many of which were pairing.

The same district was visited again on May 13, 1913. It had been under water for several weeks, during the spring floods of 1912, which may account for the scarcity of chinch bugs that prevailed. Only six were found in a day's search over the territory where they had occurred so abundantly in 1911. Four of these were in the fourth instar and two were in the third. The season was backward and on that date the buds on the cottonwood trees had not unfolded.

On June 4, 1914, the same vicinity was examined, but a two days' search netted only two chinch bugs, both adults.

On November 6, 1915, an entire day was spent searching for chinch bugs at Glasgow, but not one could be found. During the summer of 1919 this territory was searched on two different occasions but no chinch bugs were discovered.

Indications of Hibernation of Nymphal Stage

Kelly and Parks[2] state that in Kansas and Missouri in 1909 the

[1] Bureau of Entomology—Bulletin 69, page 10.
[2] Bureau of Entomology—Bulletin 95, Part III, page 28.

first newly transformed adults were secured on July 5. Headlee and McColloch[1] state that at Manhattan, Kansas, in 1912, the first fourth instar nymphs were obtained on June 4 and were at their maximum abundance on June 30; that the first newly transformed adults were taken on June 14 and were at their maximum on July 10.

In Montana fourth instar nymphs were at their maximum abundance in 1911 as early as May 23, and probably on April 15. Newly transformed adults were abundant on June 12, and in 1914 several were secured on June 4. It does not seem possible that the seasonal history of the chinch bug in Montana could be a month earlier than in Kansas and Missouri, which are 10 degrees further south and the only reasonable explanation of the appearance of fourth instar nymphs in April and May is to assume that they hibernate in that stage.

This assumption is further strengthened by Hopkin's law of latitude, longitude and altitude[2] which states that the variation on the date of a periodical event in the seasonal activities of a plant or animal is at the average rate of four days for one degree of latitude, 5 degrees of longitude, or 400 feet of altitude. Glasgow is 10 degrees north and 10 degrees west of Manhattan, Kansas, and is about 800 feet higher. Applying Hopkin's law to the statement of Headlee and McColloch, that fourth instar nymphs are at their maximum abundance on June 30 at Manhattan, Kansas, we would not expect to find them in abundance at Glasgow until 38 days later, or July 8. Instead of this we find them in abundance on May 23 and reported in abundance as early as April 15. It therefore seems impossible that these nymphs could have developed from eggs laid that same season.

Perhaps no definite statement should be made until we find the chinch bug in its winter quarters, but the above data, together with the fact that adults, which emerged in the insectary on June 12, produced progeny which failed to mature that season, indicates that in Montana the chinch bug changes its usual habit and hibernates as a well advanced nymph.

Host Plants

In the Glasgow district chinch bugs were first noticed in a field of oats which was said to be swarming with nymphs in May and the owner was very positive in his statement that many of the young plants had been killed. Chinch bugs were also found in June upon wheat and corn, but as far as could be learned no serious injury occurred.

Chinch bugs occurred most abundantly upon the native grasses.

[1] Kansas Agricultural Experiment Station, Bulletin 191, page 303.

[2] Jour. of Econ. Ent., Vol. 10, No. 1, page 160.

In June, 1911, the writer found that nearly every clump of bunch grass upon the open prairie harbored from one to twelve adults and during the first week in May unbroken sod land in the vicinity was said to have swarmed with nymphs.

Forms Found

Both long and short winged forms were found in about equal numbers.

Distribution

The area so heavily infested by the chinch bug in 1911 lies south of Glasgow between the Milk River and the Missouri River and covers at least four square miles. During the same year an area of five or six square miles lying north of the Milk River in the vicinity of Glasgow was examined in many places, but not a chinch bug could be found. At Hinsdale, 30 miles west of Glasgow, several chinch bugs were found in the first two wheat fields examined, but no more could be found anywhere during a five hour search. It therefore seems probable that while the most severe infestation in 1911 was in the district south of Glasgow, the insects also occurred scatteringly over a much larger territory. It has not been abundant at Glasgow since 1911.

On July 2, 1915, an adult chinch bug was taken by H. L. Seamans at Brady, which is 240 miles west of Glasgow and only about 40 miles from the continental divide. The elevation at Glasgow is 2,087 feet and at Brady 3,800 feet.

Source of Infestation

The finding of the chinch bug in Montana is not surprising, for it has long been threatening the southern and eastern borders of the state. In 1905, Webster[1] mapped it as occurring over all the eastern, southern and central states, and as far north as Manitoba. The western boundary of the infested area passed through central Colorado, out into the southeastern corner of Wyoming, passed diagonally across western South Dakota and cut North Dakota almost in half. It is probable that from this infested area the chinch bug has slowly worked its way up the valley of the Missouri River.

Mr. E. D. Ball: Have you had these chinch bugs examined by specialists?

Mr. J. R. Parker: They were examined by Mr. Van Duzee.

Mr. E. D. Ball: I collected a species of chinch bug in the northern part of the state of Colorado, beyond the present range of the chinch bug and they were determined by Professor Montandon, the world's specialist on chinch bugs, as a different species from that in the south.

[1] Bureau of Entomology Bulletin, 69, page 11.

MR. J. R. PARKER: I might say we found both long- and short-winged forms.

MR. E. D. BALL: That sounds rather suspicious.

MR. J. R. PARKER: We found these at an elevation of 2,087 feet.

DR. L. O. HOWARD: When did you send your specimens to Montandon? Before the war?

MR. E. D. BALL: Ten years before the war.

MR. COTNAM: Our main method of control in Kansas is based upon the hibernation of the bug. Since 1910 we have examined hundreds of grasses and found that they go into hibernation, but we have never found them after the middle of December. We do find that in Kansas we have a variation of the hibernation and a variation in the appearance. Sometimes the bugs leave hibernation in March and are found early in the spring. In other years, the bugs do not leave hibernation until May.

PRESIDENT W. C. O'KANE: The next paper is by Mr. Haseman.

THE HESSIAN FLY AND FACTORS INFLUENCING ITS RELATION TO WHEAT PLANTS

By LEONARD HASEMAN

(Withdrawn for publication elsewhere.)

Adjournment.

Scientific Notes

A Predaceous Enemy of Bean Weevils. While watching a bean weevil (*Bruchus quadrimaculatus* Fab., ovipositing, in June, 1919, the writer became convinced that there was something abnormal about its actions. After the weevil had deposited each of four eggs, it stroked its elytra with its hind legs; rapidly whipped its antennae back and forth; tried to bite its fore tibiae; extended its head as far as possible beneath its body; tried to roll over and then extended its wings as if to fly; closed them up and ran rapidly about, stopping frequently to scratch at its mouth. It tumbled about in a most excited manner. Examination showed a tiny mite attached to its labium.

The abnormal movements were undoubtedly efforts to rid itself of the intruder. At that time the weevil did not enlist the sympathies of the writer but it rather gave him satisfaction to see how its enemies were after it. Later, however, his sympathies were with the weevil because of the torture it was forced to bear.

Although numerous eggs were deposited on the beans in this container, careful observations showed that only a few adult weevils emerged from them. Upon opening the beans several dead larvae and pupae were found together with numerous large round masses which proved to be gravid female mites. Several of the latter were put into a jar of black-eyed cowpeas from which many weevils were emerging. While the actions of the weevils showed that the mites were busy, several hundred eggs were deposited before the last weevil died.

When the dead weevils were removed from the jar many were carrying gravid female mites protruding from under their wings. The following day the writer broke out with a case of "small-pox," this being the best description for the many pustules on his arms and body. Some days later, after again handling the mites, he experienced a

recurrence of fiery, itching dermatitis. About that time a collaborator complained that he would have to get treatment for a terrible itch with which he said the cooties in the trenches in France were tame in comparison.

The mites multiplied rapidly, killing some of the larvae and many of the pupae of the following generation of beetles and the weevils that did emerge were immediately attacked by great numbers of mites and were killed within a few hours. Vigorous, uninfested females of *B. quadrimaculatus* when placed in this jar were, in some instances, dead within two hours and none were able to survive twenty-four hours *B. obtectus* Say, however, fared better when put into the same jar. They were able to rid themselves of the mites by using their mouth-parts as a comb through which they drew their legs and antennae, which were thus cleaned of mites, and these in turn were used for brushing their bodies. The mites were killed but not eaten. Of thirteen *B. obtectus*, five survived more than twenty-four hours.

It was while examining the dead weevils inside the beans that the writer became well covered with those minute disseminators of intolerable fiery pustules. One hundred eighteen pustules were scattered about on his person at one time and it was then that his sympathies were with the weevils. The mites completely prevented the emergence of another generation of weevils. According to Dr. Ewing, the mites are probably *Pediculoides ventricosus* Newp.

A. O. LARSON,
Scientific Assistant, Alhambra, California.

Hawaiian Sugar Cane Borer in Costa Rica—A Correction. In my note on some insect pests of Costa Rica, published in this JOURNAL (vol. 12, No. 3, p. 269) I committed a grave error in reporting *Rhabdocnemis obscura* from Zent, C. R. It should have been the Banana Root Borer, *Cosmopolites sordidus* Germ. The error was due in confusing *C. sordidus* with *Metamasius hemipterus*. I am indebted to Dr. E. A. Schwarz for the correct identification. The Banana Root Borer is also quite abundant in Panama and the Canal Zone, together with *Metamasius sericeus* Oliv.

JAMES ZETEK.

Zeitschrift für angewandte Entomologie. Information received through Dr. L. O. Howard discloses the necessity of securing a large number of American subscribers if the *Zeitschrift* is to continue. There are now relatively few complete sets, volumes i–vi with "Beihefte," available. The price of the complete series is $16.00. It may be secured through Prof. K. Escherich, Forschungsinstitut für angewandte Zoölogie, Munchen, Germany.

Tree Hoppers and Alfalfa. Young orchards in Michigan have recently been suffering severely from the attacks of one of the tree hoppers, presumably *Ceresa bubalis*, the injury being perpetrated in the autumn when the eggs are laid on young apple trees of the first or second year. Observations made within the past few weeks have shown that, at least in the majority of cases if not in all of them, this injury has occurred in young orchards set out in alfalfa, one orchard in the southern part of the state was set half in alfalfa and the other half in plowed ground with the result that the latter half was entirely free, while the part of the orchard in the alfalfa was very badly infested,—the eggs being so thickly distributed in the young twigs that many of the trees will be deformed. Following this observation Mr. R. M. Hain, extension specialist in this department, visited the region in question and reports that in every case where severe injury from tree-hopper attacks have occurred, that young trees have been set out in alfalfa, while young trees in the same region not set in alfalfa ground appear to have escaped with slight if any injury. This would seem at first to be rather more than mere coincidence.

R. H. PETTIT,
Entomologist of Experiment Station, Michigan Agricultural College.

JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

JUNE, 1920

The editors will thankfully receive news items and other matter likely to be of interest to subscribers. Papers will be published, so far as possible, in the order of reception. All extended contributions, at least, should be in the hands of the editor the first of the month preceding publication. Contributors are requested to supply electrotypes for the larger illustrations so far as possible. Photo-engravings may be obtained by authors at cost. The receipt of all papers will be acknowledged.—Eds.

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The complexity of nature and the many interrelations existing between animals and plants and between many representatives of both major and minor groups in both kingdoms, renders exhaustive investigation and the reaching of well defined conclusions a matter of great difficulty. There has never been more need of solving scientific questions than at the present because of the more or less direct bearing they have upon increased production and the national welfare. The problem of the permanent pasture recently discussed by Professor Herbert Osborn before the Society for the Promotion of Agricultural Science, is only one of many demanding expert knowledge in widely varied lines before it can be answered in a satisfactory manner. Entomology is one of the special sciences and insects frequently play a most important part in inhibiting, sometimes in promoting, greater production, and here and there insects react upon other groups and are in turn reacted upon. The solution of a general problem such as that mentioned above is proportional to our knowledge of the least understood group exercising a vital influence upon the environment. There is need, as pointed out by Professor Osborn, for a more comprehensive, better coördinated study in the case of general problems. Such work may be conducted under the direction of a well recognized authority along general lines, capable of bringing to his aid such expert assistance as may be necessary or the same end may be attained by the specialist seeking the coöperation of others and arranging for a harmonious prosecution of all necessary special studies in relation to the general problem. There are a limited number of the former group at liberty to undertake the supervision of new lines of study and comparatively few individuals in this class are in a position to appreciate the significance

of certain facts with the same force as the specialist. On the other hand, it is not always easy to find a specialist with a breadth of training and experience which makes him capable of appreciating the coördinate value of related lines. Nevertheless, consideration for human welfare demands the solution of many problems and it behooves official agencies to endeavor to meet this need more fully by inaugurating comprehensive and well coördinated investigations for the solution of some of the more pressing general problems. It is quite possible that the National Research Council can perform a most valuable function in determining possibilities along these lines and work out one or more feasible methods of coördinated study and thus assist in utilizing to better advantage the numerous scientists and scientific agencies scattered throughout the country.

Current Notes

Dr. L. O. Howard sailed for Europe May 15.

Mr. J. L. Horsfall has recently been appointed instructor in Economic Entomology at the Pennsylvania State College.

Prof. T. D. A. Cockerell and Mrs. Cockerell expect to sail for England July 10 and will not return to Boulder until August, 1921.

Mr. R. N. Chrystal of the Entomological Branch, Canadian Department of Agriculture, who has recently been ill, is now in England.

Word has just been received that Mr. Richard Helms, Sydney, New South Wales, Australia, a foreign member of this association, died a few years ago.

Dr. H. C. Wood, formerly professor in the Medical School of the University of Pennsylvania, and a student of the Myriapoda, died January 3, 1919

Mr. R. W. Leiby, assistant Entomologist of the North Carolina Agricultural Experiment Station is secretary-treasurer of the North Carolina Academy of Science.

Mr. C. P. Clausen of the Bureau of Entomology, who was recently appointed to undertake a study of the parasites of the Japanese beetle is now in Japan for that purpose.

Mr. F. C. Bishop, of the Bureau of Entomology, recently made a trip to various counties in New York for the purpose of investigating the ox warble fly situation in that state.

Mr. T. H. Jones of the Bureau of Entomology, has completed a preliminary survey of the entomological situation at Fort Myers, Fla., and has resumed his work at Baton Rouge, La.

Messrs. F. M. Chipman, brown-tail moth survey, and L. M. How, Annapolis Laboratory, have resigned from the Entomological Branch, Canadian Department of Agriculture.

Miss Emily L. Morton, a student and artist, who worked on the Lepidoptera with Dr. A. S. Packard, W. H. Edwards and others, died at her home, New Windsor, N. Y., January 8, 1920.

Mr. E. R. Barber, Bureau of Entomology, expects to return to Cuba shortly for the purpose of collecting and shipping to this country parasites of the sugar-cane moth borer. The results of his shipments in 1919 have been so promising that the Louisiana

Sugar Planters' Association has provided four assistants to accompany Mr. Barber to Cuba this year. This insures an increased supply of the parasites for colonization in the Louisiana cane fields.

A number of shipments of nursery fruit stocks received from France this spring and consigned to different points in the United States and Canada, have been found infested with the brown-tail moth.

Mr. C. C. Hamilton, Columbia, Mo., has recently accepted a position as assistant entomologist at the Maryland Agricultural Experiment Station. He will be engaged in research on the Adams fund basis.

The Bureau of Entomology has discontinued its laboratory maintained at Seaview, Wash., in coöperation with Washington Agricultural College, where important problems relative to Cranberry insects have been solved.

Professor R. C. Osburn and Dr. C. H. Kennedy of Ohio State University are members of the staff of the Lake Laboratory, which is now permanently located at Put-in-Bay on Lake Erie, and its summer session will open on June 21 and close August 1.

Mr. E. R. Van Leeuwen of the Bureau of Entomology, who has been temporarily in Washington, has recently been placed in charge of the Bureau's laboratory at Cornelia, Ga., where life history studies of the codling moth in that region will be made.

Dr. H. M. Parshley of Smith College, Northampton, Mass., will again conduct field courses during July and August, at the thirty-first session of the Biological Laboratory of the Brooklyn Institute of Arts and Sciences, at Cold Spring Harbor, Long Island, N. Y.

Dr. C. J. S. Bethune, Professor of Entomology, Ontario Agricultural College, Guelph, Ontario, was elected a Fellow Emeritus "in recognition of his long and faithful membership," by the Council at the St. Louis meeting of the American Association for the Advancement of Science.

Mr. Claude Wakeland, Deputy State Entomologist of Colorado in charge of alfalfa weevil investigation during the three years 1917–19, has accepted the position of State Extension Entomologist with the University of Idaho. Mr. Wakeland's permanent headquarters will be at Boise, Idaho.

Messrs. J. W. Sauer and J. M. Reilly, entomological inspectors in Texas, and W. M. Mingee, W. H. Carpenter, and L. M. Pritchard, field assistants in insect control, have severed their connection with the Bureau of Entomology. The last three will be connected with the Mississippi State Plant Board.

Mr. E. H. Strickland, of the Entomological Branch, Canadian Department of Agriculture, recently visited St. Paul and Minneapolis to confer regarding stored product insects, and also arranged coöperative experiments with the members of the staff of the University of Minnesota on the control of cutworms.

Professor Vernon L. Kellogg, Stanford University, California, has been elected a member of the American Philosophical Society. According to "*Science*" Professor Kellogg recently addressed the New York Alumni Society of the Phi Beta Kappa, and also the Washington Academy of Sciences, on "Europe's Food in War and Armistice."

The State College of Washington has recently acquired the entire collection of Dr Oliver S. Westcott, the veteran entomologist of Chicago, who died last July. Dr Westcott for sixty-eight years was actively engaged in amassing this collection. It contains between forty and forty-five thousand mounted specimens. The insects of his earlier years were determined by such specialists as Ashmead, Edwards, Leconte, Horn, Ulke, and Uhler. Every state in the Union is represented by insects personally

caught by Dr. Westcott. The collection of Mexican and South American butterflies is particularly interesting.

A plan for closer affiliation between the College of Agriculture of Ohio State University, and the Agricultural Experiment Station has been put into effect. Professor Herbert Osborn, of the university has been made honorary associate entomologist of the station and Professor H. A. Gossard, chief entomologist of the station has been appointed non-resident professor of entomology in the college.

Recent appointments to the Entomological Branch, Canadian Department of Agriculture, are announced as follows:—Mr. Eric Hearle, assistant entomologist, Mission, B. C.; Mr. V. B. Durling, temporary junior entomologist, Annapolis laboratory; Mr. Andrew Galbraith, temporary superintendent of fumigation, Windsor, Ont.; Miss M. McNair, temporary junior clerk-stenographer, Fredericton Laboratory.

Dr. E. G. Titus, for three and one-half years technologist in charge of the intermountain section, sugar plant investigations, Bureau of Plant Industry, and formerly entomologist of the Utah Experiment Station, has recently accepted a position as director of agricultural research of the Utah-Idaho Sugar Co., with headquarters at Salt Lake City, Utah. His efforts will be engaged along the lines of seed breeding, pest control and general improvements in the growing and handling of sugar beets.

Officers of the Entomological Society of America were elected at the St. Louis meeting as follows: President, L. O. Howard; First Vice-President, F. E. Lutz; Second Vice-President, Edith M. Patch; Secretary-Treasurer, J. M. Aldrich. Additional members Executive Committee: W. S. Marshall, G. A. Dean, J. W. Folsom, G. W. Herrick. Committee on Nomenclature: E. P. Felt, T. D. A. Cockerell, Nathan Banks. Committee on Entomology in the National Museum: C. W. Johnson, Herbert Osborn, Wm. Barnes, W. M. Wheeler, J. G. Needham.

A conference was held at the Japanese beetle laboratory, Riverton, N. J., May 14, to consider certain phases of the quarantine regulations to prevent the spread of the Japanese beetle. There were present the following entomologists and officials engaged in pest control from New Jersey and surrounding states and the United States Bureau of Entomology:—Dr. A. L. Quaintance, Washington, D. C.; Professor E. N. Cory, College Park, Md.; Professor J. G. Sanders, Harrisburg, Pa.; Mr. Wesley Webb, Dover, Del.; Dr. G. G. Atwood, Albany, N. Y.; Dr. W. E. Britton, New Haven, Conn.; Dr. T. J. Headlee, Messrs. John J. Davis, C. H. Hadley, Harry Weiss, C. W. Stockwell and other assistants, New Jersey.

A change has been made recently in the plant quarantine service of Porto Rico. Mr. E. G. Smyth, entomologist of the Insular Experiment Station and the island Department of Agriculture, who has been in charge of quarantine work for the past three years, has given up the work, and a technical board of plant quarantine has been appointed by the Commissioner of Agriculture and Labor of the Island, which is empowered to determine procedure as to quarantine matters. The board consists of four members: the director, the entomologist and the pathologist of the experiment station at Rio Piedras, and the chief quarantine inspector in San Juan.

Entomological workers in Louisiana have formed an organization to be known as the Louisiana Entomological Society. The domicile of the society will be the Natural History Building of the Louisiana State Museum, Jackson Square, New Orleans. The first president is Mr. Ed. Foster, State Nursery Inspector, who was largely instrumental in bringing the members together. Prof. O. W. Rosewall, professor of entomology at the Louisiana State University, has been elected vice-president, and T. E. Holloway, is secretary-treasurer. Meetings will be held on the first Fridays of

February, April, June, October and December, and visiting entomologists are cordially invited to attend. The society starts with twenty-five members. The membership is open to any person interested in the science of entomology.

Mr. J. S. Woodard is assistant entomologist of the Texas State Department of Agriculture, Austin, Texas.

Mr. F. F. Baird, who was engaged in spruce bud moth investigations, entomological branch, Canada Department of Agriculture, resigned April 30.

According to *Science*, Dr. Cornelius Betten, secretary of the State College of Agriculture, Cornell University, has been appointed vice-dean of the college.

The Berkeley, Cal., laboratory of the Bureau of Entomology has been transferred to Sacramento, where it will be in charge of Mr. C. M. Packard, with B. G. Thompson as scientific assistant, and Margaret Marshall as clerk.

The laboratory of the Bureau of Entomology, which has been conducted at Hagerstown, Md., was discontinued April 1, and the work transferred to Charlottesville, Va., where it will be under the direction of Mr. W. J. Phillips.

Mr. Hall B. Carpenter, formerly of the corn borer and the pink cotton boll weevil work of the Federal Bureau of Entomology has entered the New York state service as special assistant in corn borer work, with headquarters at Schenectady, N. Y.

Mr. W. V. Becker, who has recently been connected with the Pennsylvania State Department of Health, in charge of mosquito suppression work, has recently resigned to accept a similar position with the health department of the city of Philadelphia.

Mr. S. T. Sealy, formerly of the Nassau County, N. Y., mosquito extermination force, has been appointed deputy in charge of mosquito control work for Connecticut, and entered upon his duties April 19. His headquarters are at the Agricultural Experiment Station, New Haven.

Transfers in the Bureau of Entomology have been made recently as follows: M. C. Lane, Forest Grove, Ore., to Ritzville, Wash.; W. B. Cartwright, Knoxville, Tenn., to West Lafayette, Ind.; Charles H. Gable, Tempe, Ariz., to San Antonio, Tex.; B. G. Thompson, Forest Grove, Ore., to Sacramento, Cal.

Canada has recently enacted regulations prohibiting the importation of alfalfa hay for feeding, packing, or other purposes from Idaho, Utah, and from Uintah, Sweetwater, and Lincoln counties in Wyoming, and Dennison and Gunnison counties in Colorado, on account of the danger of transporting the alfalfa weevil.

Mr. Harry F. Dietz, who was formerly connected with the Federal Horticultural Board and the Bureau of Entomology, as an entomological inspector, has accepted the position of assistant entomologist with the Department of Conservation, Division of Entomology, of the state of Indiana, with headquarters at Indianapolis, Ind.

Dr. W. Dwight Pierce announces the merger of The Gage-Pierce Research Laboratories with the United Reduction and Metal Company of Denver to form The Mineral, Metal and By-Products Company. Dr. Pierce is managing director of the Biological Department. The offices of the company are Suite 308, Continental Trust Building, Denver. Entomologists visiting Denver are cordially invited to call.

Dr. Oliver S. Westcott, principal of the Waller High School, died July 31, 1919, in his 85th year. Dr. Wescott was an entomologist and collected insects in nearly all parts of the United States, Canada, Alaska, Mexico, Cuba and Hawaii. His insect collection of about 45,000 specimens has been purchased by the State College

at Pullman, Washington, and his library was sold to John Sherman, Jr., Mount Vernon, N. Y. Dr. Wescott published several notes in *Entomological News*.

Recent appointments to the U. S. Bureau of Entomology have been announced as follows:—Cereal and forage crop insect investigations, Herbert Walkden, Wichita, Kans.; Kenneth M. King, Charlottesville, Va.; Ralph A. Blanchard, West Lafayette, Ind.; H. N. Bartley, E. G. Brewer, J. W. Enright, T. R. Richardson, Saul Phillips; Claude E. Towle, L. B. Sanderson, Dexter H. Craig, Arlington, Mass.; E. M. Searls, Schenectady, N. Y.

Mr. D. B. Young, assistant state entomologist of New York, has been temporarily detailed in charge of special field investigations of the European corn borer and study of control methods provided for in a supply bill item of $5,000 appropriated by the New York State Legislature. The work will be in coöperation with and supplemental to the investigations being conducted at the U. S. Bureau of Entomology corn borer laboratory located at Schenectady, N. Y.

According to *Science*, Dr. W. M. Wheeler, Dean of Bussey Institution of Harvard University, delivered an address at Syracuse University, May 6, under the auspices of the Society of Sigma Xi. The address was on "Worm-lions, Ant-lions and some Eighteenth-Century Entomologists," and covered observations made by Réaumur and other early naturalists upon the habits of the worm-lion and ant-lion, and included the studies of the lecturer upon the structure and behavior of the worm-lions of California.

The following appointments to the entomological branch, Canada Department of Agriculture, have been announced: Mr. H. G. Crawford, entomologist, field crop and garden insects, Ottawa; temporary seasonal assistants, Mr. E. P. Donat, Annapolis, N. S.; Mr. E. P. Venables, Vernon, B. C.; Mr. R. Glendenning, Agassiz, B. C.; Mr. J. G. Arnason, Lethbridge, Alta.; Mr. A. M. Crawford, Mission, B. C.; Mr. R. N. Bissonnette, Ottawa; Mr. J. A. Clock has been appointed temporary junior entomologist at Strathroy, Ont., and Mr. V. C. Smith, temporary messenger at Ottawa.

Dr. W. M. Mann, of the Bureau of Entomology, has just returned from a month's trip of exploration in Spanish Honduras, where he went to obtain a first-hand knowledge of the fruit-fly and other insect pest conditions in that country on account of the active commerce in fruits and other products, which is now going on between Spanish Honduras and the United States, principally through the port of New Orleans. Some six vessels arrive at New Orleans weekly from Spanish Honduras, bringing bananas, chiefly, but also citrus fruit, egg-plant, and miscellaneous fruits. Dr. Mann has already bred out no less than four different species of fruit flies from material collected, and in addition to that has notes and specimens illustrating a good many other fruit insects of greater or lesser importance.

Mr. U. C. Loftin, of the Bureau of Entomology, was commissioned early in the year, to make an investigation of the insect pests of cotton in Porto Rico, more particularly to determine if it is advisable to permit Porto Rican cotton seed to enter the United States for milling. In the course of this work he also investigated the cotton situation in San Domingo, at the request of the San Domingo government. No pink bollworm was found either in Porto Rico or in San Domingo, but a large list of other cotton insects, most of them well-known enemies of this plant were collected. A cotton blister mite, was found, which is not known to occur in the United States; and the occurrence also of certain cotton diseases in the Island, notably an internal boll disease, which seems to be widely distributed through the West Indies and prob-

ably new to the United States, would seem to indicate the undesirability of allowing the cotton seed to come into this country.

Some twenty-four boxes of parasitic material for use in the corn borer investigations arrived at the port of New York during the week of April 4. This material was shipped from Bordeaux, France, by W. R. Thompson of the Bureau of Entomology, who is in charge of a laboratory which has been established at Auch, Gers, France, for the purpose of studying and collecting the European parasites of *Pyrausta nubilalis.* This material was immediately trans-shipped to Boston in charge of Harry L. Parker, and the primary parasites emerging from it very probably will be liberated in suitable areas in eastern Massachusetts during the next few weeks.

The first annual conference of entomological workers in North Carolina was held in Room 21, Animal Husbandry Building, North Carolina State College, April 17, 1920, at 2.30 p. m. The following program was presented:

The Work of the Division of Entomology, Department of Agriculture and State Experiment Station. By Franklin Sherman.

The Work of the Department of Zoölogy and Entomology, State College and Experiment Station. By Z. P. Metcalf.

Discussion of Projects: Corn Stalk-borer and other projects. By R. B. Leiby.
Homoptera and other projects. By Z. P. Metcalf.
Cotton Boll Weevil and other projects. By F. Sherman.
Insect Survey and other projects. By C. S. Brimley.
Corn Root Worm and other projects. By Mr. Spencer.
Household Insects. By Mr. Haber.
Bee-keeping Extension Work. By C. L. Sams.
Nursery Inspection. By J. E. Eckert.
The English Sparrow. By Dr. Williams.
Extension Work in Entomology. By Mr. Smith.

LOUISIANA ENTOMOLOGICAL SOCIETY

A meeting of entomologists was called at New Orleans on March 5 to consider the formation of an entomological society or club. The meeting was attended by ten persons interested in entomology, including two from Baton Rouge, and it was decided to form The Louisiana Entomological Society.

The first regular meeting of the society was held on April 2 at the Natural History Building, Louisiana State Museum, Jackson Square, New Orleans. A constitution and by-laws was adopted, and the following officers were elected: President, Mr. Ed. Foster; Vice-President, Mr. O. W. Rosewall; Secretary-Treasurer, Mr. T. E. Holloway. The Executive Committee is composed of the officers with the addition of Messrs. O. K. Courtney, Charles E. Smith and T. H. Cutrer.

Any person interested in entomology, whether a resident of Louisiana or not, is eligible for membership. The present membership consists of about twenty-five people.

T. E. Holloway,
Secretary-Treasurer.

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(*Continued from p. 322*)

PAPERS READ BY TITLE

DUST AND THE SPRAY GUN IN CALYX WORM CONTROL[1]

By LEROY CHILDS, *Entomologist and Pathologist, Hood River Experiment Station, Hood River, Oregon*

Ever since the late Dr. A. J. Cook carried on some calyx worm control experiments in Michigan a half century ago entomologists have argued one way or another relative to the way and in the amounts this poison becomes established in the calyx cups. The correct type of nozzle and the type of spray necessary to accomplish best results has been a much mooted question. In this connection some of our more enthusiastic colleagues have even gone so far as to believe that one well timed calyx application would be sufficient to handle the codling moth under ordinary seasons of infestation.

Observations made by investigators in different parts of the country during recent years have pointed out that the percentage of calyx entrants is a very variable factor during different seasons in different sections. It has been the writer's observation that during some seasons a very high percentage of the worms enter through the calyx and during others the reverse would be true. During the past season the worms entered in about equal proportions through the calyx and side on Spitzenbergs, while in Newtowns, side entrants occurred in a

[1] The manuscript was received too late for insertion at the proper place in the Proceedings.—ED.

much larger proportion. From information that I have received from various sources a condition of this sort was quite general throughout the northwest during the past year.

It is not my purpose to in any way depreciate the importance of the calyx application in the minds of the orchardists. The more stress that we can lay upon this and the cover sprays the better will be the results. However, over emphasis of the calyx application has been harmful in that it has had a tendency to depreciate (in the minds of the growers) the value of cover sprays and much worminess has been the result.

The writer has been keeping in very close touch with codling moth activities in Hood River for six years. During the past four years experimental work with dust and sprays of various sorts has been under observation.

The dusting method of applying arsenate of lead and sulphur to apples for the control of various insects and plant diseases created much interest following the publication of the work of Reddick and Crosby[1] in 1914 and 1915. The results of their work indicated that apple insects and diseases of importance in the East, other than San José scale and the various apple aphids could be controlled in about the same degree as with the liquid. In the West we have to add to this list of uncontrollable troubles, powdery mildew, anthracnose, and the leaf roller as well as a few minor insect pests. This fact places a very decided limit upon the general utility of the method and makes it a means of general control that we can not recommend.

The results of Reddick and Crosby are especially interesting to me as I have been able to duplicate their results with scab and codling moth control during the four years of the investigation. To the entomologist working on codling moth control these results should be decidedly significant. Reddick and Crosby do not go into the critical analysis of the proportions of calyx and side worms yet their good results indicate that they accomplish calyx worm control. How can the advocate of the so-called driving calyx spray explain this control? The writer's work shows that this control is very decidedly accomplished. The dust cannot be driven. Quiet air—atmosphere—is the carrying medium used in placing the dust particles on the surfaces which require protection. A wonderful coating can be given a tree even to its uppermost branches. Upper and under surfaces of the leaves as well as the fruit alike are covered. This air conveyor being in motion, a slight breeze, very light indeed, upsets the plans of procedure. A breeze makes it almost impossible to hit the tops and even if this were accomplished the particles are moved past the surfaces so

[1] Bulletins: 354 and 369 Ag. Exp. Sta., Cornell University.

fast that only a very small percentage sticks. The remainder passes on and is wasted for the most part. When the air is quiet these particles will hover for a long time over a tree and gradually settle. Air currents destroy the plan of the system and applications made under such conditions can only result in disaster.

In order to avoid windy conditions it was found necessary to dust very early in the mornings; a calm usually occurs in most sections of the valley during this period of the day. However with us during the spring months it is not uncommon for a wind of varying degree to occur continuously for several days at a time. Many times in the carrying out of the experimental work the dusting had to be postponed for more favorable weather. We are all familiar with the fact that successful applications of spray cannot be delayed to any great extent and at the same time accomplish results. Several of our growers have used the dusting method; for the most part their work has been done regardless of air movement. In 1918 the condition of the fruit in one of these orchards was checked up; a 33 per cent injury from the codling moth was found. None of the growers of the valley have depended upon the system during the past year. On account of the many handicaps and difficulties encountered I do not recommend the method to our growers except those located on steep hillsides and in sections where sufficient water for spraying is difficult to obtain.

The results, however, that have been obtained in calyx worm control have a very decided bearing on the results that can be expected with the spray gun when properly used. For this reason I will discuss some of the results that have been obtained in seasons past with both dust and liquid applications. These results are summarized on the accompanying chart. In 1917 the unsprayed check trees in an orchard which had been quite wormy for several seasons, developed an infestation of 65.13 per cent. Of this infestation 31.68 per cent were side worms and 68.32 per cent were calyx worms. (Exp. 5 in table.) The variety used in this set of experiments was Arkansas Black. This ratio did not hold true in all varieties. In an orchard of Spitzenbergs this ratio was 66.96 per cent side worms and 33.04 per cent calyx worms. In a Newtown block this ratio was 61.54 per cent to 38.48 per cent side and calyx worms respectively. In the block of Arkansas Blacks two dust experiments were checked against two blocks of trees sprayed with twelve foot rods. In Experiments 1 and 3 an early September application was omitted resulting in a much more wormy condition than occurred in Experiments 2 and 4 (see table). These different experiments are cited to show, that regardless of this marked difference in worminess, the general relation of side and calyx worms remains fairly constant, though with the increase in total worminess the chances

of calyx entrants also increases. The very marked difference between the figures obtained on the check trees as compared to both dusted and sprayed indicate the influences that are brought to bear in calyx worm control. Experiment 2 (dust) gave the best calyx worm control during 1917 where the ratio was found to be 92.99 to 7.01, side and calyx worms respectively. Experiment 4 (rods) followed with a 80 to 20 ratio. The gun was not tested in this orchard in 1917. These blocks as has been stated were sprayed extra in September. The rods in the heavier infestation gave slightly better calyx control, 73.55 per cent being side entrants as compared to 71.6 per cent in the dust block.

Dusting work was not continued in the Arkansas Black orchard in 1918 but was continued in a block of Newtowns in a different orchard. As will be noted in Experiment 6 the check block for this series of experiments developed a 17.64 per cent infestation. During this season throughout the district a greater percentage of side worms entered than calyx worms. The unsprayed (Exp. 8) checks developed 73.29 per cent side worms as compared to but 26.7 per cent calyx worms. However, regardless of this rather small percentage of calyx worms the difference of amount in calyx worm control is again pointed out in the results obtained. During this season calyx entrants were cut down to 5.2 per cent in the dust block. These results were checked against a block sprayed with a gun in the same orchard which developed but .44 per cent wormy fruit (Exp. 7), and perfect control as far as calyx worm control is concerned. This work was continued in these same blocks in 1919, and though not presented on the chart gave the following results. The check trees developed 80. per cent side and 20 per cent calyx infestation. The figures in the dust block are 96.77 per cent side worms and 3.22 per cent calyx worms. Unfortunately the gun block upheld the 1918 performance and developed not a single calyx worm in the apples counted. The figures look too good but nevertheless these are the ones obtained. At this point I might add that this orchard, outside of the experimental work that has been conducted with dust, has been sprayed with a gun only since 1917.

Before being too firmly convinced of the relative merits of calyx worm control with dust and with spray gun a series of experiments were arranged in 1919 to compare the merits of the gun and rod in an orchard which had been quite wormy for several years. The orchard which was chosen for this work suffered a loss of 20 to 30 per cent damage in 1918. In 1917 the loss was even greater. In the spring of 1919 many worms were found on the trunks of trees so there was no doubt but that there would be plenty of insects with which to work. Three blocks were chosen through the center of the orchard. One was

TABLE I—RELATION OF SIDE TO CALYX WORMS
HOOD RIVER, OREGON, 1917, 1918 AND 1919

Exp. no.	How applied	Total per cent worms	Per cent side worms	Per cent calyx worms	Relation of side to calyx worms in per cent
1917					
1	Last spray omitted	12.96	9 28	3.68	71 6 to 28 4
2	Dust	5.37	5.00	.37	92.99 to 7 01
3	Last spray omitted	14 33	10.54	3.79	73 55 to 26 44
4	Rods	1.43	1.14	28	80 00 to 20 00
5	Check	65.13	20 62	44 51	31.68 to 68 32
1918					
6	Dust	2 68	2 54	.14	94 7 to 5 2
7	Gun	.44	44	0	100 00 to 00
8	Check	17 64	12 9	4 7	73 29 to 26 7
1919					
9	Rods in calyx, guns in other sprays	2 39	2 05	34	85 74 to 14 28
10	Gun all sprays	2 27	1 91	35	84 24 to 15 71
11	Rods all sprays	3 41	3 12	29	91 64 to 8 54
12	Guns, fruit from 1 to 12 ft. high	1 08	99	09	90 9 to 9 0
13	Guns, fruit from 12 ft. to tree top	5 1	4 2	9	81 13 to 18 86
14	Check	53 6	24 2	29.4	45.16 to 54 83

Note—1917; Five standard sprays applied unless otherwise stated.
1918; Four standard sprays applied.
1919; Five standard sprays applied.
In Exp. 12, fruit separated from ground to 12 feet Exp. 13, from 12 feet to top of trees.

sprayed with the gun throughout the season (Exp. 10). Another was sprayed with twelve foot rods throughout the season (Exp. 11). Experiment 9 gives the results obtained with the use of rods in the calyx application, guns being used for the other sprays. The varieties used in the test were Jonathans, Newtowns, and Spitzenbergs. The tree were fifteen years of age. This discussion, presented in the accompanying table, with the exception given, includes the results obtained in the Spitzenberg block only. The spray was applied by the owner and his hired man under the supervision of the writer who followed behind the men while the trees were being sprayed in each application. Two guns were used on a 3½ power outfit of a well-known make. The work was well done and well timed throughout the season. Five applications of arsenate of lead were used during the year; the last one, as the season finally turned out, was not very important. A summary of the results not only shows that the gun held its own in obtaining codling moth control but gave better control than the rods and also where the rods were substituted in the calyx application that the calyx cups

might be filled. The check trees (Exp. 14) developed an infestation of 53.6 per cent; the ratio of side to calyx worms was 45.16 per cent to 54.83 per cent. In Experiments 9 and 10 (rods in the calyx and guns in all applications) the percentage of calyx entrants was found to be practically the same, .34 and .35 per cent. The ratio of side to calyx worms being 85.74 to 14.28 per cent for the rods and 84.24 to 15.71 per cent for the guns.' It is interesting to note here that the field control obtained by the owner two rows away from the check trees ran .56 per cent wormy, fruit being checked up at random at harvest time. This demonstrates what can be done in a badly infested orchard in a season with a spray gun.

Another point upon which there is no experimental information available is the matter of worm control in the tops of large trees with the guns. At picking time the fruit was segregated in the different experiments in lots from the ground to 12 feet and from 12 feet to the tops of the trees (Exps. 12 and 13). The trees in question were quite tall, considerable fruit occurring from 20 to 25 feet from the ground. Up to a height of 20 feet effective control can be obtained; above this point, however, effectiveness rapidly decreases. For example, in one tall tree 123 apples (which are included in the results given in Exp. 13) were picked at a height of 25 to 28 feet; 22 of them were found to be wormy. No fruit occurred at the greater heights in the blocks sprayed with the rods so that comparative figures are not available. The results would seem to indicate that very good calyx and side worm control can be expected up to a height of 25 feet, above which point very poor protection is accomplished.

From figures which I have been accumulating it appears that the codling moth is inclined to deposit more eggs in the tops of the trees than nearer the ground. It is quite important then that the fruit should either not be grown at that height or should be very well sprayed in order to reduce worm infestation to the minimum. This could be accomplished by spraying from a tower.

The poor results that have been obtained with the spray gun are not due to the principal involved in applying the spray. Unsatisfactory control can be the result of the misuse of one of three—or perhaps better—the combination of three misused factors. These are poor equipment, poor work and irregularity of application. Of the three factors, the first mentioned is probably the most important from the standpoint of the use of the gun. The other two factors are contingent upon the first. The spray gun is a useless accessory on a poor spray outfit. It is little better than nothing and will never give good results. Our up-to-date 3½ horse power sprayers are indeed too small to handle two guns effectively, they will handle one in good shape. A machine

of this power, in order to throw a spray of the proper quality must maintain a pressure of at least 275 pounds. In the experimental work just referred to a machine of this character was used. In order to keep the spray in proper form it was tuned up and punished throughout the season. When one begins to punish a gas engine and pumps trouble, then the owner of this machine has his share. This condition of affairs existed in many orchards throughout the valley and was typical of no particular make of sprayer. A spray machine, in order to live the life that it should and at the same time deliver the goods must have a liberal reserve. A machine of 10 horse power is none too much. Such spray machines are now coming into use and it will be only a question of a very few years until all of the present so-called modern sprayers will go into the discard. The results given in Experiment 7 were obtained with one of these larger types of sprayers. The control presented here is undoubtedly better than would be accomplished by the average orchardist—it is at least significant.

The gun where operated with small inferior equipment has given a very poor account of itself. I have carefully checked up the results obtained in several orchards where poor equipment has been used. The growers tried to do good work and timed their application well. Breakdowns and low pressure, which is usually the rule when a machine is not working right have lead to very poor results. The lower fruits as a rule came through the season in fairly good shape. In 1918 in one of these orchards under observation the following records were made. Apples growing below 12 feet developed a worm infestation of 3.55 per cent. Apples growing between 12 feet and the tops of the trees developed an infestation of 17.63 per cent. There is only one explanation for this condition and that is the fact that the spray was not applied properly to the tops of the trees.

Low pressure from these small capacity outfits does not produce a spray of the proper consistency to accomplish a satisfactory coating. The liquid leaves the gun in a coarse, splattering stream. There is no fineness of division of the particles and the only way that a tree can possibly be covered is to drench and thereby waste much material. As I have said before it is my belief that finely divided spray which has much the same consistency of the dust particles—which controls calyx worms operates in the case of properly applied liquid solutions. If this spray is not broken up into a light drifting mist the principal of calyx worm control is destroyed and poor results are bound to follow. There is no possible chance of obtaining much calyx protection in tops of trees with a gun throwing a coarse splattering spray. This might possibly be accomplished from a tower. Gravity is the factor which allows the poison to reach the calyx ends of the uppermost apples. The

spray material must be placed there in the proper condition and in sufficient amounts to effect a coating as it falls. A coarse spray goes up in large droplets and comes down in much the same form. Unless a very excessive amount of spray material is thrown into the top of the trees only a few of the calyx ends will receive much spray and these will be decidedly spotted.

In summarizing then, the successful use of the spray gun depends almost entirely upon the manner in which the spray is broken up. A pressure of 250 pounds on the large sprayers, *i. e.*, the 10 horse power machines delivers a beautiful spray from two guns. This amount of pressure on a small outfit does not produce the same sort of spray. It takes at least 300 pounds with a 3½ horse power outfit to approach this spray and then it is nowhere nearly as good. I am not sufficiently versed in mechanics to explain just why this difference occurs. Nevertheless there is a difference and anyone who will handle the delivery from the small and large outfits can immediately feel the difference in the "life" of the spray. I am not conducting a propaganda for any one large type of sprayer, unfortunately at the present time there is only one on the market. Our other sprayer manufacturing companies must bring up their standards if they are to meet the demands of the orchardists for there will be a very great demand for these during the next few years. With the coming of increased facilities for proper spraying I firmly believe that we will see a marked improvement in our codling moth control and a yearly saving which will amount to many thousands of dollars.

Summary

The percentage of calyx entrants in apples is a very variable factor. In some seasons larger percentages enter than in others. There is much variation in different varieties of apples.

The percentage of calyx entrants is not as great in the Northwest as one would be led to believe in reviewing the literature on the subject.

Dust controls calyx worms. It can in no sense of the word be called a "driving application." The material settles upon the locations needing protection and accomplishes results if properly applied; this including calyx protection.

Spray applied in finely broken up particles operates in exactly the same way whether applied with a rod or spray gun.

The spray gun, in order to produce the proper type of spray cannot be used on inferior equipment. Two hundred and seventy-five pounds pressure with a 3½ horse power sprayer produces a fair spray with two guns—an excellent spray with one gun. There is a very great need for higher powered sprayers with a liberal reserve. To be entirely effective the gun must be backed up with such equipment.

OBSERVATIONS ON THE EFFECT OF STORM PHENOMENA ON INSECT ACTIVITY[1]

By D. C. PARMAN, *United States Bureau of Entomology*

The discussion will deal primarily with the effect of barometric pressure on insect life as other storm phenomena—wind, rainfall, temperature, atmospheric moisture, etc.,—have been more fully studied and discussed in general literature and time and space will not allow more than brief reference to these to make the matter clear. No experimental data have been gathered, all observations being made in natural surroundings and in cages used in other experimental work. Most of the observations have been made on Muscids and related diptera, only general notes being made on other insects in the field and at lights.

Until the fall of 1916 no barometer was available at the Uvalde, Texas, laboratory where the observations recorded herein were made. This permitted only of studies of the daily map of the Weather Bureau in connection with records made on insect activities. In the fall of 1916 a compensating aneroid barometer was obtained and since that time regular readings have been made at 8:00 a. m. and 8:00 p. m. with special readings at time of storms.

The first observation made on a storm of any severity was on the West Indian hurricane which passed over southwest Texas on the night of August 18, 1916. Some of the more significant data relating to this storm will be given from an extract of the "Monthly Weather Review" of August, 1916, and this publication should be consulted for fuller details. "The tropical cyclone passed inland between Corpus Christi and Brownsville the afternoon and evening of the 18th. After passing inland a short distance south of Corpus Christi the cyclone continued to move in a west-northwest direction, reaching Del Rio, Texas, at about 7:30 a. m. local mean time August 19, with a minimum pressure of 28.69 inches. Since it passed Corpus Christi, 200 miles distant, 12 hours earlier, we may assign a movement of about 17 miles per hour. The recovery of the pressure after the passage of the center of the storm was extremely rapid. . . . We must consider that it dissipated over southwest Texas during the daylight hours of the 19th. . . . It is worthy of note that all of the tropical cyclones of August, 1916, were characterized by remarkably small diameters and naturally extremely steep barometric gradients near the center only. . . . And the fact that the centers did not closely approach any of the network of land stations except for a very brief period, the location of the center of the storms in each case was a very unsatisfactory matter . . . (Corpus Christi). The barometer reached its lowest point,

[1] Published with the permission of the Chief of the Bureau of Entomology.

29.05–29.07 inches reduced to sea level at 6:15 p. m. . . The wind . . . estimated maximum velocity of 90 miles. . . . There can be no question that the storm was a fully developed hurricane with a central pressure at least one inch lower than observed at Corpus Christi."

The following table gives data at different stations.

Date	Place	Minimum pressure[1]		Maximum wind velocity		Rainfall
1916		Hour	Inches	Hour	Miles per hour	Inches
Aug 18	Corpus Christi	6.15 p m	29 07	6·50 p m.	90	1 58
18	Brownsville	7:00 p m	29 50[2]	8 30 p m	60[3]	
19	San Antonio	1·00 a m	29 63	2 31 a m	56	
19	Del Rio		28 69		60	

[1] Reduced to sea level.
[2] Lowest reading on record for month.
[3] 5 min period.

Judging from the storm damage it must have had its center in the vicinity of Uvalde, Texas, the damage being less both north and south. The rainfall at Uvalde was 3.1 inches and the wind was probably about 75 miles per hour. Not a single windmill was left standing, many small buildings were wrecked and doors and windows were blown from the most substantial houses in the immediate vicinity of Uvalde, the path being in a southeast to northwest direction.

August 18, 1916 was a pleasant summer day about three degrees cooler than the several preceding days, a maximum of 90 and a minimum of 71. The wind was blowing a light breeze from the northeast instead of the usual southeast breeze at this time of the year. No barometer was at hand and no warning of the storm was had except the clustering of the flies. Nothing unusual was noted until about 8:00 p. m., the wind changed to the northwest and became stronger until it was blowing a gale at 2:00 a. m. From 2:00 a. m. to 3:00 a. m. it was changeable and gusty. Probably a little before 3:00 a. m. straight winds from the southeast began to blow and buildings and trees began to fall.

Previous to the storm, only a few days, *Stomoxys calcitrans* were very abundant and annoying the stock much in the farming districts east of town. After the storm stockmen and farmers made the assertions that the flies were very bad the day before the storm but they had seen very few since. Examinations of certain stock were made eleven days before the storm and they were almost covered with stable flies, while after the storm no individual animal had more than five or six

flies upon it. At the laboratory, where from one to more than five thousand *Musca domestica* and *Chrysomyia macellaria* were taken in periods of 48 hours in traps before the storm only 8 to 31 were taken after the storm during the remainder of the season (trappings were made semi-monthly on 1st and 15th). About 5:00 p. m., August 18, attention was drawn to large numbers of house flies on the screens about the house; many of the screens being literally covered and they were found to be collecting in protected places. A bucket of kitchen refuse was examined where only a few hours before hundreds of *C. macellaria* and *M. domestica* were feeding and only a few specimens of *C. macellaria* were found deep in the bucket and no *M. domestica* were present. After the storm it was rare to see more than two or three specimens of either species for a period of ten to fifteen days. All species of diptera diminished appreciably with the storm, but of the ones under observation Lucilia sp. was least affected.

During the last three years observations have been made on several species of Muscids showing that with a rapidly falling barometer they first become nervously active and then go into a state of partial coma. Some species have a tendency to seek a place of protection at this time, others show this tendency very little but become quiet at a most convenient place. While the flies are in this state of coma they are more subject to action of other destructive agencies, probably diseases included. Heavy rains are destructive to insect life to some extent, as has been observed by other writers and workers. The chilling effect during the storm might have contributed to some extent to the destruction of the flies as the minimum for August 19 was 67 degrees. Mechanical action of the wind and action of sea spray possibly contributed to the destruction, but it is evident that the destruction of flies during this storm was rather unusual and the unusual characteristic of the storm was the very steep and short barometric gradient.

Another tropical storm visited this section September 14 and 15, 1919. This storm was very similar to the storm of August 18, 1916, except the barometric gradient was not so steep and the wind was not quite as strong but lasted longer. The barometer began to fall on the evening of September 13 from 29.05. It was 28.85 on the morning of the 14th and 28.65 in the evening, 10:00 p. m. 28.60, 11:00 p. m. 28.55, September 15 at 1:30 a. m. 28.45, 2 a. m. 28.50, 3:30 a. m. 28.40, 4:00 a. m. 28.50, 5:00 a. m. 28.45, 6:00 a. m. 28.50, 8:00 a. m. 28.50, noon 28.70, 8:00 p. m. 28.90. The rainfall was 3.75 inches. The wind was blowing a strong breeze from the northeast on the morning of the 14th and increased to a high wind by 10:00 p. m. and to the proportions of a storm by 2 a. m. September 15, at which time it became changeable to the southeast and blew from 50 to 60 miles an hour until

about 4:00 a. m. and probably was blowing 40 miles at 6:00 a. m., and a strong wind was blowing at 2:00 p. m. and a moderate breeze at 8:00 p. m. The maximum temperature of the 13th was 91, the minimum 70; 14th, 80 maximum, 72 minimum; 15th, 80 maximum and 67 minimum.

The decrease in the number of flies was quite appreciable after this storm; the abundance of flies before the storm was about the same as before the storm of 1916 except *Haematobia irritans* which was very numerous prior to the late storm and was not abundant before the storm of 1916. This fly was practically exterminated during the recent storm, adult *C. macellaria* decreased about 75 per cent, *M. domestica* decreased about 50 per cent and *Stomoxys calcitrans* about 25 per cent. Adults of all species under observation were decreased to some extent. After the storm of 1916 there was never any appreciable increase in the number of adult flies, although weather conditions were apparently very favorable for increase. After the recent storm the increase in all species was rapid. This increase became noticeable about 15 days after the storm, this being approximately the duration of the immature stages of the species concerned. It is quite probable that many of the immature stages as well as the adult flies were killed during the storms. This is caused by the washing and drowning of the larvæ, as was noted in the last storm and may possibly be augmented by sea spray. It has been determined in preliminary experiments that a solution of sodium chloride as weak as .25 per cent is detrimental to breeding of some species of Diptera in certain cases. This destruction of larvæ and pupæ, together with the almost complete destruction of adults during the first storm, left a very few flies to breed and this together with the variable barometric pressures and storms never allowed an increase that was noticeable during 1916. The larger percentage of adults and the more uniform barometric pressure allowed maximum breeding after the 1919 storm.

A typical observation on the reaction of adult flies to barometric pressure was made on November 21, 1916. Several hundred *Lucilia sericata* and *C. macellaria* were in a cage at the laboratory and under observation. They became very active from 9:00 a. m. to noon and during this time the temperature increased from 66 to 75, the humidity fell from 87 to 60 per cent, the wind was blowing a light breeze from the northeast, the barometer rose from 29.05 to 29.15, at 2:00 p. m. the temperature was 74, humidity 56, the wind a light breeze and a little more from toward the east, the barometer was 28.95 inches, the flies were all quiet and most of the Lucilia were in hiding. The day was clear except for a few medium cumulus clouds clearing toward evening. The barometer fell slightly until 6:00 p. m., when it began to rise and the wind changed to the northwest blowing in a strong norther.

The following observation gives some light on the effect of barometric pressure on the death rate of adult *C. macellaria*, showing that the adults apparently will not chill and die under the effect of a rising barometer as under a lowering barometric pressure. The adults under observation on November 24 were taken in the open and put in a cage November 20 and 22, a total of 366. The adults under observation November 27 were taken under the same conditions November 25 and 26, a total of 500. Between noon and about two o'clock on each date observations and counts were made of the dead flies on the floor of a cloth cage 2 ft. cube with board bottom, this cage being inside of a 6 ft. cube cage made of screen wire. November 24, the first cage contained 87 flies alive and 279 dead flies. Nov. 27, 83 dead flies were taken from the second cage and the others became active in a warm room. Thus showing a 76.2 per cent mortality in the first case under a falling barometer as compared with a 16.6 per cent mortality in the second under a rising barometer. It is believed that other conditions could not have caused this wide difference in mortality. The following table gives the weather conditions under which the observations were made:

1919	Temperature		Barometer		Humidity	
Date	Maximum	Minimum	8·00 A M	8 00 P M	Maximum	Minimum
Nov 23	75	61	29 45	29 15	93	65
24	70	55	29 05	28 90	98	87
26	79	18	29 05	29 00	87	36
27	54	48	29 25	29 35	98	86

Observations made at lights and at room windows at nights indicate that insects attracted to lights are more active during high barometric periods and especially while the barometer is rising. No specific determinations have been made to indicate the relative degree of reaction of different species under any particular condition.

Bred adult Diptera tend to emerge on periods of rising barometer, the heavy emergences apparently always have been during high barometer. Trappings and observations indicate that Muscoid diptera are most abundant during long periods with slight variations in barometric pressure, provided, of course, temperature, humidity and rainfall are favorable.

Migration of *Lybithea bachmanni* was observed during the summer and fall of 1916 to take place after storms which indicates that the flights were during high barometric pressure.

THE CONTROL OF BREEDING OF YELLOW FEVER MOSQUITOES IN ANT-GUARDS, FLOWER VASES AND SIMILAR CONTAINERS[1]

By JAMES ZETEK, *Entomologist, Board of Health Laboratory, Ancon, C. Z.*

We find, continually, larvæ of the yellow fever mosquito (*Aedes calopus* Meigen) in ant-guards, flower vases and similar containers. We have ample protection from yellow fever due to our intensive sanitation and efficient quarantine, and perhaps, also, our *calopus* population is so low that no danger exists. But not all places are as fortunate as Colon, Panama City and the Canal Zone. Hence any method that will aid in the reduction of *calopus* breeding will have ready application. The method proposed in this paper is not offensive, it is easy to apply, and should result in a great diminution of these mosquitoes. Properly carried out it should eliminate a great deal of friction between the public and the sanitary corps.

I am greatly indebted to Mr. Ignacio Molino, Jr., entomological laboratory assistant of the Bureau of Entomology, U. S. D. A., stationed at the temporary field station at Ancon, for placing at my disposition his big garden in Panama City, for carrying out experiments there, and for making the routine inspections. This garden had forty-six ant-guards protecting choice rose bushes from the nightly ravages of leaf-cutting ants.

To merely empty out the water each day or so, and again refil, is not enough because the calopus larvæ cling tightly to the bottoms of the guards. The usual practise has been to pour some of our larvacide, or some crude oil, into the ant-guards. This "fixes" the larvæ, but the rains wash out this insecticide, it gets at the roots of the rose bushes and as a result many of these are killed. Their productivity is always greatly lowered. Sometimes the ant-guards are purposely broken so they cannot hold water, a simple, effective way out of a difficulty; but this gives no protection against the ants. These measures, therefore, only anger the owner and cause considerable ill feeling toward the sanitary corps. But this is not all; usually after finding larvæ or pupæ the second or third time, the owner is fined. This cannot leave him in a happy mood. As a result, coöperation suffers. Yet, the owner is not always to blame. The mosquitoes are domestic in habits; they must breed; ant-guards are favorable habitats for them. And, man has right to flowers.

Vases in houses have always been prolific *calopus* breeders. It is also difficult to inspect thoroughly every house, and as a rule, the fact

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[1] Published by permission of Col. H. C. Fisher, Chief Health Officer, The Panama Canal.

that the sanitary inspector is on his tour is made known long before he arrives. The people soon learn to fear flower vases, hence many will hide them so the inspector will find none. Here, also, fines are about the only outcome, and the result is the same as with ant-guards,—ill feeling toward the well-meaning sanitary corps. But, if the people know that there is a substance which they can place in their flower vases and thereby prevent *calopus* breeding, especially so when the substance will not affect the flowers, then coöperation increases and the sanitary inspector can do more thorough work. The days of actual ignorance as to the importance of yellow fever are gone; nearly all of Central and South America wants to clean up and get rid of this scourge. Hence it is believed the people will fall into line and be of real service in this work of eradication, especially so when all frictions between them and the sanitary forces are made as few and as small as possible.

Other containers exist in houses. Of these the ant-guards used to protect tables and ice boxes from ants, are as easy to control as are the ant-guards in gardens. But the *tinajas*, or water reservoirs, are somewhat difficult to handle because the people must have drinking water, and in tropical climates the *tinajas* keep this water cool. The best control is to substitute them with a water pipe system and a good, clean reservoir and such other means as will give these people good drinking water in sufficient abundance. Not all places can afford a first class water system, hence the sanitary corps must aim, by means of periodic inspections, to have *tinajas* cleaned out and kept free from yellow fever larvæ; at any rate pupæ should never be found. It is remarkable how much a water pipe system reduces the number of containers, and as a consequence *calopus* breeding, in houses.

Another application of the method proposed in this paper, is in the urns containing holy water in the Catholic churches. These always will breed yellow fever mosquitoes unless some method of control is undertaken; it is not an infrequent sight to see the congregation scratching their ankles while the services are going on.

The method proposed consists of adding small quantities of powdered camphor or para-dichlorobenzene to the containers. Lump camphor may be used in flower vases and holy water urns. Naphthalene was found to be unsatisfactory unless used in finely powdered form. About two grams per liter of water was found to be enough, but no minimum dose was determined because it was thought best to be on the safe side. Outdoor conditions, especially heat, rain and débris modify considerably the character of the contents of the container, hence enough of the chemical should be used, and two grams per liter was found to be satisfactory if repeated once a week during the rainy season.

It is believed best that the central station of the sanitary department should keep on hand a supply of the para-dichlorobenzene and sell this to the people at, or nearly at cost. This measure will prevent high costs and will place the substance within easy reach of all. After the details of the application of the insecticide have been made known, then no excuse should be held valid for having *calopus* larvæ in such containers, and if the town has yellow fever, then the offenders, no matter who they are, should be dealt with to the fullest extent of the law.

The following is a brief synopsis of our experiments: (1) A preliminary test was made at the laboratory using camphor and para-dichlorobenzene in powdered form, one gram to a liter of water. Twenty-five *calopus* larvæ were placed in each jar. The camphor floated on the surface whereas the other substance remained on the bottom. The larvæ showed greater distress, at first, in the camphor jar. Three hours later all larvæ were found on the bottom of the jars. Those in the para-dichlorobenzene lot were in great distress, due, of course, to the greater concentration of the substance at this level. There were only five larvæ alive in this jar, but they were unable to wriggle up to the surface. In the camphor jar there were eight larvæ still alive. These tried at times to reach the surface, but were repelled when near it by the camphor in the water. Two hours later all larvæ, in both jars, were dead. In the control lot, the larvæ behaved as *calopus* larvæ should, pupated in due time, and adults emerged.

To determine whether the camphor or para-dichlorobenzene impart any odor to roses, or in any way affect their duration, three roses were placed in a jar containing a liter of water and two grams of camphor; three were placed in another vase containing instead two grams of para-dichlorobenzene. A check lot was also kept. After two days no change in color took place. The roses were then submitted to several people at the laboratory to note if any change in odor was noticeable. There was no change noted, in fact, the flowers looked exactly like the control lot.

(2) A similar test was made with pupæ; one gram of camphor, and one gram of para-dichlorobenzene to a liter of water was used. Three hours later all the pupæ in the para-dichlorobenzene jar were dead and on the bottom. In the camphor jar all pupæ were at the surface; three out of the ten were dead, but the living were in very great distress. Upon shaking the jar to make them descend, they found great difficulty in again reaching the surface. One hour later all pupæ were dead.

(3) A large screen cage, 3 feet by 3 feet by 3 feet was used. In it were placed three moistening jars, 10 inches in diameter by 3 inches high, each with a liter of water. To one of these was added

powdered para-dichlorobenzene (2 grams); in another was placed powdered camphor (2 grams); the third was kept as a breeding chamber for *A. calopus* and received at frequent intervals larvæ and pupæ. Raisins and dates were used as food for the adults that emerged, though at times I would place my forearm against the screen and allow twenty-five fortunate mosquitoes to have a blood meal. Several hundred adults were always in this cage, and copulation in the air was a very frequent sight. The object of the experiment was to learn whether the mosquitoes will appear in the treated waters. The test was continued for one month. During this period *no* larvæ were found in the treated waters. In the breeding jar, however, there were a large number of very young larvæ, showing that oviposition was taking place. Enough water was added to all jars to make up for loss due to evaporation. It would appear that both camphor and para-dichlorobenzene act as repellents.

(4) This experiment was made in Mr. Molino's garden, and was carried out to learn the efficacy of the method under actual field conditions. The garden is divided into two parts, each with about the same number of ant-guards. All of these were emptied, scrubbed out well and allowed to dry for three hours. They were then filled with tap water. To ten of these was added powdered para-dichlorobenzene, two grams to each guard. To ten others, powdered camphor was added, two grams per guard. These twenty treated guards were well scattered among the others. Six days later the first inspection was made. No larvæ were found in the treated guards. Nearly all of the controls had larvæ. During this 6-day period we had twenty-six hours of fairly heavy rain. This test indicates that the method proposed is effective.

The infested ant-guards were emptied, scrubbed out and filled with tap water. The twenty treated guards were left exactly as they were. Five days later an inspection was made; this was eleven days since the chemicals were first introduced. Three of the camphor treated guards and two of the para-dichlorobenzene ones had larvæ. Six of the controls had larvæ, much greater in quantity than in the infested treated guards. We had seven hours of rain during this 5-day period. This test shows that both camphor and para-dichlorobenzene are effective in inhibiting the development of *calopus* larvæ, but due to the rains and the heat, it is necessary to add fresh chemicals once each week. But, even if ten days pass before fresh material is added, there is little danger because it is highly improbable that any larvæ that may be present would reach the pupal state.

(5) It was now thought that perhaps the chemicals could be used in lump form as well, and perhaps be effective: also, that perhaps the

ordinary naphthalene moth balls would be as good. Camphor was eliminated on account of its cost. One half of the ant-guards were given lump para-dichlorobenzene, the other half one moth ball each. A week later five of the moth ball guards had larvæ and one of the para-dichlorobenzene also. It was evident that for ant-guards lump chemicals are not as effective.

All ant-guards were now scrubbed out and left to dry for three hours. They were then filled with tap water and each of them was given two grams of powdered para-dichlorobenzene. A week later, no larvæ were present. Without any cleaning out, two grams more were added to each guard. A week later, no larvæ were present. It is believed this test proves the efficacy of powdered para-dichlorobenzene in controlling mosquito breeding in ant-guards.

It was noted that adult yellow fever mosquitoes were very abundant at first, but as these tests continued, they became less so, until when a month later, there were very few present. It was also noted that insects, particularly wasps, would be found dead at the ant-guards that had para-dichlorobenzene, evidently killed by the chemical in the water.

It may be well, at this point, to recall the experimental work of Dr. J. W. Scott Macfie[1] with common salt. He found that 2 per cent and upwards was effective, this being due to hypertonicity of the solution. In the case of para-dichlorobenzene, the action is due to the slow evaporation of the chemical with the result that the heavy vapor leaving at the surface of the water is breathed by the larvæ and is toxic to them. It forms a sort of blanket between the surface of the water and the air, thus shutting off the air supply.

(6) The following laboratory experiment was made to find out the relative value of camphor, naphthalene and para-dichlorobenzene in both powdered and lump forms. Six jars were used, three for lump and three for powdered chemicals; each was given one liter of tap water and two grams of the insecticide. The camphor floated on the surface while the other two sank to the bottom, excepting for a very small quantity of the finely powdered portion which floated on the surface film. Each jar received 25 healthy *calopus* larvæ. Three hours later (7:15 p. m.) the first observation was made. All larvæ in the jars having lump chemicals were alive, but those in the camphor showed considerable distress. These were trying to remain as much as possible below the water surface. The lump naphthalene and lump para-dichlorobenzene jars showed the larvæ at the surface mostly, and if they did descend, they would not, as a rule, go clear to the bottom

[1] 1914—A Note on the Action of Common Salt on the Larvæ of *Stegomia fasciata*. Bul. Ento. Research, iv, pt. 4, pp. 339–344.

where the chemicals were, but if they did, they would react suddenly upward upon coming into contact with same.

The jars with the powdered insecticides told a different story. Three hours after the larvæ were placed in them, many dead larvæ were found. In the camphor jar only four larvæ were alive; para-dichlorobenzene had six live ones; naphthalene had twelve alive. Two hours later showed no change in the latter jar, but in the camphor and para-dichlorobenzene lots, all were dead. The following morning at 7:30, there were still two live larvæ in the powdered naphthalene jar, but these were dead by noon. At this same hour the lump naphthalene had all of the 25 larvæ alive and *active*, as if nothing out of the ordinary had happened. The lump camphor had but four live larvæ, while the lump para-dichlorobenzene had sixteen live ones. At 4:30 p. m. that same day, all larvæ in the lump camphor jar were dead, while in the para-dichlorobenzene there were still ten alive. There were no deaths in the naphthalene jar.

The next day at 4:30 p. m. there were four live larvæ in the lump para-dichlorobenzene jar, and eighteen in the lump naphthalene one. Twenty-four hours later all larvæ in the para-dichlorobenzene were dead, but in the lump naphthalene there were still about twelve alive, of which two had pupated. These tests show that the substances in powdered form are most effective, that camphor and para-dichlorobenzene are the best, and that naphthalene is uncertain. For ant-guards powdered para-dichlorobenzene is best, but for flower vases and holy-water urns, lump camphor may be used.

(7) A similar test was made with pupæ only. Only camphor and para-dichlorobenzene were used. The lump chemicals were inefficient. The powdered forms killed all pupæ in four hours.

(8) If equal amounts (by weight) of camphor and para-dichlorobenzene are heated in a flask, they melt and form a liquid which remains a liquid at ordinary room temperatures. Preliminary tests showed this combination had good insecticidal properties, and should have ready applications under special environmental conditions. However, not enough experimental work was done with this to warrant making any deductions at this moment. This liquid settles on the bottom in the form of a flattened sphere, and may, therefore, be used with good results in holy-water urns, being less objectionable than the powdered substances.

Summary

About two grams or more of para-dichlorobenzene, repeated every seven days during the rainy season, or every ten days during the dry season, was found to prevent the breeding of yellow fever mosquitoes

in ant-guards. It is necessary that the para-dichlorobenzene be used in powdered form and be well scattered in the guards.

About two grams of powdered para-dichlorobenzene, or the same amount of camphor (either lump or powdered) was found very effective in preventing the breeding of yellow fever mosquitoes in flower vases and similar receptacles. It should be repeated every fifteen days, or each time the water is changed. For holy-water urns, especially in churches, lump camphor is recommended.

The use of these insecticides should be considered obligatory, and if, after due notice has been given, breeding is found, especially pupæ, then the offender should be dealt with severely and to the full extent of the law, particularly so if yellow fever exists in the community.

The central station of the sanitary corps should have these insecticides on hand and sell them to the public at, or nearly at cost.

MOSQUITO CONTROL IN A SOUTHERN ARMY CAMP

By S. M. Dohanian, *Bureau of Entomology, Melrose Highlands, Mass.*

Early in the spring of 1918, the writer, then an enlisted man in the Signal Corps, U. S. A., was transferred to the Medical Corps at his request, and assigned to the problem of insect control at Kelley Field, the large aviation camp located about six miles southwest of the City of San Antonio, Texas. The most important feature of the insect problem was that of mosquito control and the prevention of the breeding of the house fly. This paper will be limited to that phase of the work dealing with mosquito control.

As it would have been rather unwise to devote the entire efforts to removing breeding places in the camp proper and to pay no attention to the surrounding country where the insects might breed unmolested and fly to the camp, it was decided to cover a territory embracing the camp itself and a zone around the camp of about three miles, for unless conditions are especially favorable fresh water mosquitoes will not fly such a long distance. Exclusive of a portion of the City of San Antonio, which comes within this three mile zone, the population outside of the reservation is a little more than 450, with almost 80 per cent of them living in the small "emergency" town east of the camp, known as South San Antonio. The remainder live on scattered farms east and south of the reservation, while to the west there are practically no houses.

The camp site was originally an immense cotton field, having a deep clay soil with only an occasional bed of sand or gravel protruding above this clay formation; and while it was almost uniformly level there were depressions of varying sizes which, owing to the nature of the

soil, retained water for some time after a rain. In the three mile zone the terrain to the north, east, and southeast is similar to that of the camp but devoted to the growing of cotton and truck garden crops, while to the west and southwest the rolling country is covered with mesquites and cacti.

Upon commencing the work of mosquito control in April, 1918, the necessary work of becoming familiar with conditions within the camp and the territory adjacent to it, within a radius of three miles in all directions, was quickly completed. Each and every source of mosquito breeding, hidden or exposed, within the limits of the reservation was carefully noted for future action. Kelley Field, like all other army camps built during the recent emergency, was constructed in great haste. Consequently it caused no surprise to find gutterless roads, depressions under buildings, hollows in the open, leaky fire hydrants and underground pipes, etc. Since it was impossible to remedy all these defects at once, periodical trips of inspection were made throughout the season; all the apparent dangerous sources being visited every nine or ten days, while no effort was spared to cover the camp in its entirety at least once a month. An oiling crew of three men, one of whom was thoroughly instructed in the objects and methods of spraying and who was always in charge of the crew, would spray all temporary pools of water in which mosquitoes were found breeding. Under prevailing atmospheric conditions it was found that a combination of crude oil (70 per cent) and kerosene oil (30 per cent) gave the most desirable consistency and the best results. Because oil interferes with the proper functioning of sewage disposal plants, no oiling was done on the surface of waters which would eventually find their way into the disposal plants. Several times during the early season mosquito larvæ were found breeding in the flushing tanks of unused sanitary latrines. Since no oiling could be done in these places a man was detailed to flush weekly all temporarily unused latrines.

One of the duties of the camp entomologist was to collect, bi-weekly, specimens of mosquitoes found in the reservation for shipment to the Army Medical Museum, Washington, D. C. (as required by army orders), for a study of the relation between disease-bearing mosquitoes and local prevailing diseases. The effectiveness of the above method of inspection and subsequent treatment is testified to by the complete absence in Kelley Field of the yellow fever mosquito, *Aedes calopus* (which is known to breed in chance water in receptacles about buildings), during the entire season of 1918, although several specimens were collected in San Antonio. The following is a complete list of the species of mosquitoes found at Kelley Field during 1918, as identified by the Army Medical Museum, Washington, D. C.

Culex tarsalis; C. fatigans; C. spissipes; C. chrysonotum; C. similis; Psorophora jamaicensis; P. texanum; P. signipennis; Mansonia spp.; Anopheles crucians; A. punctipennis; A. pseudopunctipennis.

The most prolific of the above mosquitoes was *Culex fatigans*, having been found breeding from April to December inclusive; while of the Anophelinæ the commonest was *Anopheles pseudopunctipennis*, which was found breeding throughout the summer months.

The sluggish Leon Creek, which for more than four miles meandered within or in close proximity to the reservation, was at the outset condemned as the place from which would come most of the mosquitoes. In parts of its course it formed pools more than an acre in area. Its course lay through a wide ravine, in places the banks rising fifty feet in height; nowhere was it entirely free from a tangled mass of weeds and tall grasses, on the whole having the general appearance of a typical jungle (Plate 6)—an ideal source for the most prolific propagation of mosquitoes. To reduce or even eliminate as much as possible mosquito breeding in this place through the period of construction, resort was made to the use of the oils. The first two attempts were local failures. In both cases frames of wire mesh were built to fit snugly into a narrow portion of the creek near the place where it first enters the reservation. These forms were boarded on the two sides which were to be placed against the banks of the creek. The bottom, the two sides facing the direction of the stream and the top cover were made of wire mesh. This rectangular frame (about 30 inches by 36 inches by 12 inches) was filled with sawdust which had been soaked in crude oil for six hours, and then placed in position in the creek. This proved unsatisfactory because of excessive oiling for 24 hours following submergence, and because its effectiveness was of comparatively short duration, and therefore demanded frequent attention. An attempt was made to overcome these difficulties by substituting excelsior for the sawdust, but with approximately similar results. The third trial, of using a large 50 gallon oil drum as a drip, was successful. This drip was placed over the channel leading from one of the sewage disposal plants into Leon Creek. Two heavy planks stretched across the channel supported the large oil drum in such a position that the nozzle pointed into the middle of the stream. To assure the complete breaking up of the oil drops at all times as they fell into the water, two or three medium sized rocks were placed in the bottom of the channel just in front of the spot where the oil drops hit the water. These rocks caused a ripple of sufficient force to break up each drop and at the same time to direct the oil to the two sides of the channel. The same proportion of crude and kerosene oils (70 per cent to 30 per cent), which was used for general spraying, was found to be satisfactory for use in

the drip. In this manner the creek was supplied, throughout the period of construction, with a steady, uniform, and a very thin film of oil. Impurities and heavy ingredients in the oils necessitated weekly adjustments of the nozzle of the drum. Extreme care was constantly exercised to drip the minimum amount of oil necessary for the prevention of mosquito breeding, to eliminate any danger to live stock using the water down stream, and to the colonies of top-minnows living within it. In several places along the banks of the creek springs caused permanent pools of fresh water. into which top-minnows were introduced to good advantage.

It was evident that the true condition of the creek was not appreciated by the authorities until their attention was called to it by the writer upon assuming the duties of camp entomologist. On May 1, 1918, only seven Mexican laborers were engaged in improving the creek, the work being to clear the banks of the vegetation. Had its real dangerous character been realized more than seven times seven men would have been employed early in the season before the advent of mosquitoes. Considerable filling, cutting and grading were necessary to secure a thoroughly sanitary condition, particularly if the improvements were to be of a permanent nature. And the ultimate object of the anti-malarial construction was the permanent eradication of mosquito breeding in the creek. Accordingly requisitions were made not only for an increase in the number of Mexican laborers but also for as large a number of enlisted men as could daily be spared from other necessary duties to work upon this project. Because of the complex military methods of procedure some little time elapsed before the number of Mexican laborers was increased from seven to an average

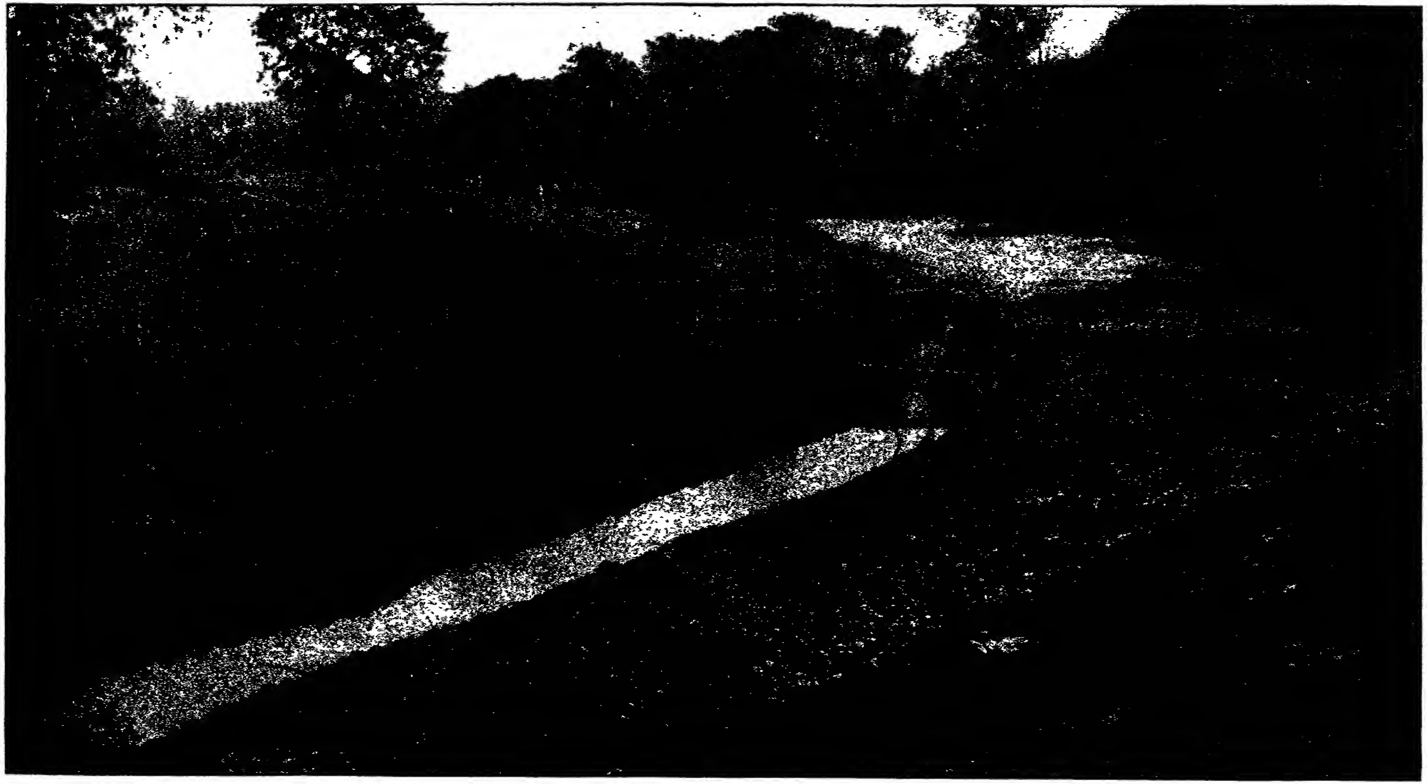
Nature of work		June	July	Aug	Sept	Oct	Nov.	Dec	Totals
Policing the creek (Figs in linear ft)		6,700	8,325	6,750	6,800	9,550	7,660	5,500	51,285 lin. ft
Banks treated (Figs in linear ft)		2,100	7,300	1,200	850	575	575		12,600 lin ft
Re-sodding (Figs in sq yds)						6,200	8,400		14,600 sq yds
Cuts made (Figs. in cubic yds)		343 8	512 5	475 1	338	521 5	826	320 3	3,337 2 cu yds
Fills made (Figs. in cubic yds)		826 7	1738 2	2643 6	1170 1	3281.	2099 3	2234 4	16,993 3 cu yds
Oil used (Figs in gallons)		65	60	50	60	60	55	35	385 gallons
Average Labor	Soldiers 6 hours/day	17	7	4	9	3	6	3	7 men per day
	Mexicans 8 hours/day	10	16	27	24	25	25	21	21 men per day

of about twenty-five. The additions were, however, gradual. The number of enlisted men available fluctuated considerably, ranging from none to fifty men daily, but with a rather low average, as will be seen from the accompanying table.

The above table gives summaries of the work accomplished monthly during the period of extensive construction on Leon Creek. The work in certain places was expedited by the use of about 200 pounds of dynamite and 35 pounds of black powder. Such necessary implements as picks, shovels, plows, scrapers, etc., used in the project were army properties. During this period an average of four double teams (of two mules each) were used for 64 days.

Had the anti-malarial construction commenced early in the spring of the year the work would have been planned on a different basis than that actually carried out. However, due to the lateness of the season the initial work was planned to consist merely of building a narrow central channel along the entire length of the creek, to grade where necessary for a steady flow of water, to fill such pools if grading did not entirely drain them, to eliminate standing pools, and to clear the banks of vegetation and other matter which would interfere with the flowage thus giving opportunity for the propagation of mosquitoes. Following this preliminary work (Plate 7); which reduced mosquito breeding sources to a minimum, the narrow central channel was permanently graded and the banks of the creek regraded where necessary, and sodded, to withstand washouts by the heaviest rains (Plate 8). This last phase of the work was well under way and nearing completion when, the Armistice having been signed, the writer was discharged from the service late in January, 1919.

Since the jurisdiction of the army authorities was confined to the limits of the reservation our work was limited to those portions of Leon Creek which were within that area or formed parts of its boundaries. However, the United States Public Health Service, with branch headquarters in San Antonio, under the direction of Major Gardner, appropriated a sum of money sufficient for the undertaking of improving the creek outside the camp bounds. The work done by them, although of material benefit in the reduction of the pests, was of a temporary nature. The splendid coöperation between the two government departments was productive of wonderful results, as was noted by Colonel Lewis, Sanitary Officer of the Medical Department for the Air Service, while on a tour of inspection of the Flying Fields, at Kelley Field in July, 1918, by the following remark, "There are very few flies in the camp and no mosquitoes."



PROFESSIONAL ENTOMOLOGY: THE CALL AND THE ANSWER

By Edmund H. Gibson, *Consulting Entomologist, Washington, D. C.*

It is always fitting that at the outset or beginning of any new endeavor or activity a definition or explanation be made of the new undertaking, especially in its relation to the old and established. Therefore, permit me to refer to professional entomology as the study and application of economic entomology for the means of a livelihood, in which one's services are sold in competition and in which one capitalizes his knowledge and places his attainments and abilities on a business basis.

Young men and women are attracted to science, in its various branches, by fascination, curiosity, the love of study, and desire to add to the world's knowledge. Remuneration for one's work has been secondary. Possibly, rightly so. But does the lawyer's desire for worldly gain and the doctor's fee detract in any way from their practice and professional or scientific ability? Rather is the money return a beneficial factor for furthering of study and bettering the professional man's ability to do increased good to his fellow men. If this is so, then those who in the future think more of financial gain than their comrades do must not have the criticism thrown against them that they are selling or prostituting science.

The writer can see no reason why entomology cannot or should not be put upon as dignified a business basis as law, medicine or engineering. There was a call for men able to state and argue facts; the lawyer was the result. There was the need for men skilled in treating and curing the sick; the doctor was the result. There was wanted those who could plan and supervise construction of all kinds; the engineer was the result. In the main, those who entered these and various other professions did so because of the need or call assuring at least fair returns for time spent in study and preparation, and unusual opportunities for financial gain, in return for ability and attainments. The call in other professions has been made and answered. Is there a call for professional entomology and is it being heard at the present time?

There was recently formed in one of our large western cities a farming corporation, with large financial backing. This company owns and operates extensive farm lands in the South. They grow and market immense crops of various kinds. Naturally, there are losses due to insect injury. Who is their consulting entomologist? They have none. Why? There was none. Why have they not called in the state entomologists, university professor, or the laboratory assist-

ant, whose services they can have free of charge? Because the men directing the affairs of the corporation are business men and want dealings with men of technical skill, with appreciation for business methods, and think more of advice paid for than given free. The pure scientist and research worker cannot be a business man; even if he were he would be forced, by institutional connections, to extend his advice prepaid.

A certain company in one of our northern states operates a chain of graineries. Each year they meet with severe insect damage, because there has been no professional entomologist who can plan and carry out fumigation operations. There is plenty of government and state literature at hand telling how to do this and that. But who is to do it?

A thriving city of nearly 50,000 inhabitants, the capital of one of the greatest states in the Union, has tried all kinds of methods of garbage disposal during the past three years. Recently, a pig farm at the outskirts of the city was established. During the summer months the city was deluged with flies. But few knew where the flies came from, and none knew how to get rid of them. Consultation with a professional entomologist would have led to fly eradication and bettered conditions. And the bill rendered would have received prompt attention.

It would be possible to go on indefinitely enumerating the openings and opportunities of consulting and contract entomologists, as you all know the field of entomology in its various branches and phases is almost limitless.

There was never a better time than to-day to establish oneself, to become known as a consulting or professional entomologist, to open up and to develop the avenues of usefulness in the conservation and production of all articles and stuffs entering into the daily existence of man.

Who will answer the call? The answer to this question is rather hard to foretell, but I might venture to suggest that success will more surely come to him who goes into professional entomology from a conservative standpoint. A certain amount of capital will be required to tide oneself over the months consumed in getting established, an office or at least desk space is necessary, a certain amount of circularizing or advertising will be found quite essential. And then there must be a reserve fund to fall back on for operations, until such operations bring in their returns.

Even a meagre and humble start will entail considerable expense. After a few individuals or firms of consulting entomologists or entomological engineers are well established, there will be openings in such firms for junior or assistant entomologists, such positions paying livable salaries.

The suggestion has been made to the writer that a professional entomologist should have a line of insecticides for sale, in other words, combine the commercial with the professional. In some rare cases this might work out to advantage, but I firmly believe that in the majority it will be more harmful than helpful. I came to this conclusion by the fact that few lawyers sell law books and doctors do not sell their medicines. There is the distinctive commercial field and also the consulting practice. Some may choose one and some the other.

No one consulting entomologist will be able to cover all phases of entomology in his practice, any more than the research worker or systematist. The attempt must not even be made. Consultation with others better informed upon certain problems must be frequent. The quack doctor runs a bluff game. A bluffing doctor only discredits himself, but in the case of a new business profession the bluffer will discredit his profession, as well as himself and his co-workers.

There must be close coöperation between the laboratory and field research worker and the professional consulting or contracting entomologist. The latter must turn to the former for certain fundamentals and the former will have to look to the professional for the strictly practical application of his methods.

The few who have already chosen to be pioneers in this new profession are sincere, modest, and we trust will prove capable.

THE VALUE OF FIELD DEMONSTRATIONS IN EXTENSION WORK IN BEE CULTURE

By L. B. Crandall, *Storrs, Conn.*

All extension workers have found that the best way to get information to another person is to carry it to him, and the best way to get him to use it is to show him how.

This is also true in other lines of education; hence, we have in nearly all of our schools, laboratories and workshops for many lines of study. You can tell a man how to do a certain task by means of a book, bulletin, or personal letter, but he will often get from that description a very different picture from what you intended. If you go to see him and demonstrate what you mean, he will get your idea clearly.

All men interpret what they read, more or less, from the background of their own experience. If their experience has not been somewhat similar to yours, they cannot interpret correctly what you write.

For these reasons I believe that field demonstrations form the most important part of extension work.

It is quite generally agreed, I believe, that a bulletin without pictures to illustrate its text is practically useless to any person who lacks

a background of experience in the subject. A demonstration adds as much to the work of an extension specialist as pictures do to the text of a bulletin.

There are many ways in which field demonstrations are valuable to the people of a state. One of them is to interest more persons in the possibilities of beekeeping. This is brought to the attention of the greatest number, perhaps, by exhibits of honey and bees at the state and county fairs. If these exhibits are accompanied by public demonstrations of handling bees in practical, up-to-date ways, much valuable information can be imparted to the public. When these exhibits are well handled, a good deal can be done to advance better beekeeping in the state.

I believe there is no great value in the so-called "stunts," except to draw a crowd, but if demonstrations are well conducted by competent beekeepers, they may be valuable extension work. I think it might be well for the Extension Service to lend encouragement and supervision to this class of demonstration work.

One of the greatest values in field demonstrations is in showing beginners right methods of handling bees. Beginners are more or less afraid of bees. They know that bees sting, and, naturally, are somewhat afraid of being hurt. They may never have seen a hive opened, so do not know what to do first. The inside of the hive is all mystery to them. They do not know what will happen when they take off the cover for the first time. They rather dread the first step in investigating the inside of a hive filled with live bees. When the demonstrator comes along with his assurance of knowledge and his confident manner of handling the smoker and hive tool, the fear and the mystery vanish. It does not seem to be such an ordeal to open a hive. Beginners gain confidence and forget their timidity. They come up nearer, alive with interest, to get all the information they can of the best ways of doing things with bees. At such a time a good demonstrator can render very great help to the beginners in his audience and gain their coöperation in all his future efforts in their communities.

The New England farmer is conservative. He is slow to adopt new ways of doing his work, or of taking up the use of new tools for doing the old tasks. The field demonstration is practically the only way by which he can be made to see any advantage in new equipment. This also applies to new methods of doing work. The way grandfather did it is too often the way the grandsons still do it.

The field demonstration gives the extension specialist a good chance to show the value of new equipment or improvements on old equipment as they are developed. Improvements in ways of handling bees, discovered by the federal and state research workers, are passed on to the beekeepers in the best way by means of field demonstrations.

Comparatively few beekeepers in the United States are conversant with the advance work being done for them by the research specialists at Washington and elsewhere. This information must be carried to the great majority of the beekeepers, and its value demonstrated, or they will never know that anything is being done for them. This kind of work has especial value to the commercial honey producer, and this is often the only kind of service which the extension worker can give such men.

Most commercial honey producers are alive to the best interests of their business in respect to increased production. They are ready to adopt improved methods of apiary management when they can be shown that such improvements are to their advantage. They have considerable money invested in equipment, and it is often expensive to make the necessary changes incident to the adoption of better equipment or to any radical departure in the apiary management. It is necessary, therefore, that the extension worker should be careful not to try to introduce new methods or new equipment until they have been thoroughly tried out and proven to be practical.

Swarming and its control are always interesting subjects for beekeepers everywhere. They are ready at all times to adopt new methods which promise a solution of this old problem. Much valuable work can be done along this line by field demonstrations.

One of the most, if not the most, important uses of the field demonstration is in diagnosing brood diseases. No amount of printed matter, even with good engravings, can make clear the difference between brood diseases. A good demonstrator can show his audience samples of each kind of disease and point out the peculiarities of each. For cases of these diseases where there are no complications, this method works very well, but in cases complicated by the presence of other organisms, only a microscopic examination will prove effective. The demonstrator of brood diseases should have a good microscope as his most important tool. At the same time the demonstrator can and should give the beekeepers an outline of the value of apiary inspection work in the control of brood diseases. It would be well in most cases if the demonstrator would also point out the fact that the inspector is the friend of the beekeeper, and that he is willing and anxious to help the beekeeper to clean up his diseased colonies and show him the best way of keeping clear of infection in the future.

The demonstrator can also make it plain why inspection work must be thoroughly done to be of any value, and why the inspector must thoroughly disinfect himself and his tools before going to another apiary. This last point is one which should have more attention from the person having state inspection work in charge.

An important office which field demonstrations should serve is that of showing the beekeepers what kind of assistance the Extension Department of their State College can render them. The extension work in bee culture is somewhat new for most of the states, so that the beekeepers have not yet learned to look to the Extension Service for help along this line. This makes it important, I think, that the extension specialist make the field demonstration an important part of his work, especially during the summer.

In our fight to eliminate poor equipment, especially the old box hive, the field demonstration has one of its greatest values. The specialist can easily show why beekeeping under such conditions is unprofitable; how inspection of bees in box hives is impossible and that disease will run riot unchecked; how the hives cannot be manipulated to secure the highest production of honey; and how swarm control methods cannot be used successfully, consequently, colonies often swarm themselves to death.

For these reasons I believe the field demonstration as a means for extension work in bee culture has a great future, and that its possibilities have, as yet, been but lightly touched.

WESTERN TWIG PRUNERS

By Frank B. Herbert, *Scientific Assistant,*[1] *Los Gatos, Calif.*

There are several beetles in the West which prune twigs and small branches from a number of trees. Apparently all are native species, but work upon exotic as well as indigenous plants. They bore into twigs, varying from one-eighth to a quarter inch or more in diameter, often entering where two branches fork and following down the center for a short distance. This weakens the twigs, generally causing them to break down from their own weight or during a windstorm. The small branches usually die back beyond the point of attack, offering excellent entrances for fungi and other insects.

This peculiar habit is not for the purpose of forming a brood gallery nor a breeding place in any sense, but seems to be done in order to obtain food, particularly when a considerable lapse of time occurs between emergence and egg laying.

Single individuals only are found in each burrow. These remain but a short time and then abandon them, presumably to mate and lay their eggs.

Polycaon confertus Leconte (family Bostrichidæ), often called the olive twig borer, is the one most commonly met with. It is a rather

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slender brown beetle about one-half an inch long, occurring in California and Oregon. It usually bores in at the forks of two small branches, entering for a quarter inch or more and throwing out considerable frass behind it. Young trees are occasionally quite seriously damaged by the attack of the beetle.

The following is a list of the plants from which the twigs are pruned by this species: almond, apple, apricot, avocado, birch, cherry, currant, English elm, *Eugenia myrtifolia*, fig, grape, live oak, olive, orange, peach, pear, prune, and the strawberry tree (*Arbutus unedo*).

The beetle does not breed in many of these trees, however. Its eggs are laid in the dead wood of acacia, almond, apple, Oregon and silver maple, manzanita, live oak, tan bark oak and rose. The larvæ mine in the sap- and heartwood of these trees for a year or possibly more and finally emerge in the early summer as beetles to perhaps prune a few twigs before producing their progeny. Probably only a very small percentage of the emerging beetles ever assume the habit of attacking the small branches.

There are no practical methods of control for the beetles entering the twigs. Part of the injury might possibly be prevented by the application of repellent or poison sprays, but the trouble seldom becomes serious enough to warrant their use. Hand picking may be resorted to, but the beetle has probably already abandoned the branch when its condition becomes noticeable, or else most of the damage has been done when the beetle is found. The most satisfactory control measures are to destroy all possible breeding places during the winter or early spring by burning all dead logs and stumps of the host plants.

Polycaon stoutii Leconte, a larger, black species, is also reported to prune twigs in the same manner, but has not been observed to do so by the writer. It breeds in California laurel, coast live oak, madrone and manzanita, and attacks the branches of almond and *Eucalyptus globulus*. This species occurs throughout California.

Apate punctipennis (Leconte) (family Bostrichidæ), called the western twig-borer, burrows into the twigs of different orchard trees, particularly apricot, much in the same way that *Polycaon confertus* does. It is a dark brown beetle, about one-half an inch long and differs from the latter in having its head well under the thorax, which bears prominent tooth-like processes. The western twig-borer occurs throughout the Pacific southwest. Mesquit appears to be its native host plant, but it has also been bred from the wood of apricot, fig, grape, pear and orange.

Phloeosinus cupressi Hopkins and *P. cristatus* Leconte are bark-beetles belonging to the family Ipidæ, which also have the abnormal habit of pruning small twigs. These resemble each other a great deal

and are small, stout, cylindrical, brownish black beetles, about three millimeters, or an eighth of an inch long. The habits of the two species are very similar, so they are discussed together. Both are native to California. Dr. Hopkins, in an article in 1903, mentioned the fact that the former was a twig pruner. The writer has discovered that *P. cristatus* is also responsible for part of the injury.

Both breed in a number of cypresses and cypress-like trees, and may even be found working together in the same tree. They attack in numbers and excavate galleries several inches long under the bark, parallel to the grain of the wood, and lay their eggs in small niches on each side of the galleries. Upon hatching, the larvæ mine away from the galleries in the cambium and thus girdle the trees, transforming to beetles at the ends of the mines, *P. cupressi* pupating under the bark and *P. cristatus* a short distance in the wood.

Under certain conditions, part of the emerging young beetles attack small branches about one-eighth inch in diameter, entering through the bark and mining down the centers of the twigs, leaving nothing but thin exoskeletons of bark to support the tips. Consequently, many twigs break down from their own weight. The beetles may do this in order to obtain food or to await the coming of their team-mates in order to make a concentrated attack on the next tree. Beetles are very seldom found dead in a twig burrow, which fact helps to substantiate the theory that the beetles leave them to make brood galleries and rear young elsewhere. One female removed from a food burrow and placed in a cage with a section of cypress, proceeded to make a short gallery under the bark and lay eggs therein. They were apparently infertile, for none hatched, on account of the male placed in the cage having failed to find the gallery of its mate.

Both sexes have been found in the twigs, but always only one beetle to a gallery. They have been captured in the following months: March, June, July, August, October, November and December. Upon careful search, however, they probably could be found during the other months as well. Most of this work is done in the spring and fall, while a majority of the injured twigs drop from the trees during the first heavy windstorms of the fall. Part of the injuries to the trees heal over after being abandoned, but usually a distinct swelling or elbow remains at the point of attack.

To indicate the number of twigs which are often pruned from a single tree, the writer raked together those under an ordinary sized monterey cypress and thus obtained a pile two and one-half feet high and nearly as wide, and still many more remained on the tree, giving it a very dilapidated appearance.

Phloeosinus twig work has been noted on the following cypresses:—

monterey (*Cupressus macrocarpa*), arizona (*C. arizonica*), guadalupe (*C. guadalupensis*), macnab (*C. macnabiana*), funeral (*C. funebris*), italian (*C. sempervirens*), lawson (*Chamaecyparis lawsoniana*), hinoki (*Ch. obtusa*), and arbor vitæ (*Thuya orientalis*), giant arbor vitæ (*Thuya plicata*), and incense cedar (*Libocedrus decurrens*).

The beetles may be best controlled by burning up the infested trees, posts or poles in which they are breeding, or by removing the bark when they are in the younger stages, killing them by exposure. This will reduce the numbers liable to enter the twigs.

The injured twigs may be trimmed from the trees, making them more presentable. Poison or repellent sprays have never been used, but may be of value in preventing the twig injury.

Three specimens of a scolytid bark-beetle were discovered by the writer in broken twigs of ash (*Fraxinus spp.*) on the Stanford University campus in May, 1919. Many other twigs were broken down and wilted, showing the results of their work. Later, upon a closer examination of the ash trees in this locality, a great many of the twigs were discovered to have been entered, while only a small percentage had been broken down. The entrances were found mostly at a bud or the axil of a twig, with the burrows spiralling down the twig under the bark for a quarter inch or more.

The old brood galleries of these beetles were found in the dead tops of three nearby ash trees which had been killed apparently by this species. The parent galleries were under the bark, extending transverse to the limb, while the larvæ which hatched from the eggs laid in niches on the sides of the galleries, mined parallel to the grain of the wood. All the limbs had been abandoned, but a dead beetle was found in a pupal cell, which proved to be identical with those in the twigs.

Upon forwarding a specimen of the beetle to Dr. Hopkins at Washington, D. C., he pronounced it as apparently an undescribed species of *Leperisinus* near *aculeatus* Say. He also stated that an allied species, *L. fraxini*, had been reported to be injurious to twigs in Europe, but that he believed no such injury had been reported in America.

Among other twig pruners may be mentioned *Agrilus angelicus* Horn, the flat-headed oak twig girdler, the larva of which in making its spiral mines under the bark of various oak twigs, which it kills, occasionally goes deep enough into the wood to so weaken the branch that it is broken off by the wind. Two unidentified cerambycid larvæ also work upon larger twigs of oak and sometimes cause the same injury. No work resembling that of the eastern hickory girdler, (*Oncideres cingulata* Say), has been observed in the West.

(*Proceedings to be continued in the next issue*)

SOME RESULTS WITH NICOTINE AND NICOTINE COMBINATIONS IN EXPERIMENTS ON THE CONTROL OF LASPEYRESIA MOLESTA BUSCK[1]

By Louis A. Stearns, *Associate Entomologist, Virginia State Crop Pest Commission*

Judging from the published results of limited experimental work of both field and laboratory character, uncertain success has accompanied endeavors to control the oriental fruit moth as a pest of peaches. It would seem that the vulnerable point in the life-history of the insect, as well as the insecticide most effective in combating it, are yet to be determined. The writer, in common with others engaged in a close study of the moth, discovered, early, that applications of arsenical sprays to the fruit, foliage and twigs of infested peach trees, although of some occasional benefit to the sprayed trees, in most instances were apparently of negligible value, since the larvæ feed largely within the twigs and fruit. At first, it appeared, also, that applications of 40 per cent nicotine sulphate, either alone as an ovicide or in combination with an arsenical near hatching time, failed to materially control the insect.

However, it has been encouraging to note that in the young, well-cared-for commercial orchards of extreme northern Virginia the moth was absent. The Virginia infestation is primarily an area of small and scattered home-garden plantings. Commonly one third of the twigs of such trees are tunneled out and killed by the larvæ of this peach pest, and an equally high percentage of the fruit is usually "wormy." Although the few commercial plantings, cultivated, pruned and sprayed in conformity with the best orchard practices, are in close proximity to these heavy infestations, the moth has been unable, apparently, to establish itself.

In view of the seeming discrepancy between experimentation and local field observations, experiments were conducted in 1919 with the intent of ascertaining accurately the toxic value of several insecticides, both alone and in combination, in detailed laboratory tests with individual eggs and just-hatched larvæ of the moth, and in limited field tests with single infested peach trees.

The results of the previous season's investigation, which had pointed to the likelihood of controlling the moth most successfully in its egg stage, had emphasized also, in view of the egg-laying habits of the insect (deposition on under surface of leaves), the necessity of increasing the spreading and sticking possibilities of whatever insecticides employed,

[1] The investigation of which these results are a part is discussed in detail in the Quarterly Bulletin, Virginia State Crop Pest Commission, April, 1920.

by their combination with some material possessing these specific characteristics. Sea moss solution (prepared by boiling 4 pounds of "Irish" rock moss for one hour, straining and diluting to 50 gallons of water) and a casein-lime mixture (proportions 1 part casein to 3 parts hydrated lime; rate 1 pound to 50 gallons of water) fulfilled best these requirements. Microscopic examinations have shown that, in instances where the insecticide had failed to kill an egg, and the young larva had succeeded in projecting the head partly through the forty-five degree angled aperture which is made, the thin flakey film of sea moss served often as a barrier to halt the normal hatching process at that point. The inexpensiveness of this material repays largely the time and labor involved in its preparation. Applications of calcium-caseinate resulted in a uniform conspicuous coating of the foliage, which, in field tests, persisted for a number of weeks despite heavy rains.

Laboratory Tests

The method of procedure included the confining of moths in ten-inch breeding cages (double height) in the box bases of which one-year-old peach stock had been planted. Life-history studies in 1918 had shown that a high percentage of infertile eggs were deposited, due undoubtedly to laboratory conditions of confinement. The eggs deposited upon the foliage of these trees were, therefore, given a careful examination with a hand lens. Thus only those eggs which presented a well-rounded normal appearance and were apparently viable entered into the experiments. In applications, which were made with an atomizer, care was taken to hold the atomizer in such a position that only the spray mist floated over the foliage. Twenty-one experiments, comprising twenty-four tests with eight insecticides, in which a total of 2,877 eggs were studied individually under a binocular microscope, were conducted at the Leesburg Field Laboratory. Following applications, each egg was examined daily to observe the effect of the sprays and to secure accurate hatching records.

The results with nicotine in these experiments seem a further contribution to our knowledge of the usefulness of this material, and as such deserve special notice. In view of observations made in experiments of the preceding year, the efficiency of the nicotine-arsenical combinations in Table I has been computed by comparing the total number of eggs not hatching and larvæ dead 36 hours after hatching, with the total number of eggs employed. The percentage of kill for all these combinations in which nicotine sulphate (40 per cent) occurs as a toxic constituent may be computed as 79.69. The results with nicotine sulphate (40 per cent) and sea moss stand alone, 95.40 per cent of the

eggs failing to hatch. The data of these tests showed, in addition, that the efficiency of all insecticides varied directly with the time following deposition at which the application was made. Records indicate an even gradation from 87.95 per cent failing to hatch with application on the day of deposition to 55.78 per cent failing to hatch with application just prior to hatching.

TABLE I—RESULTS WITH NICOTINE AND NICOTINE COMBINATIONS IN LABORATORY TESTS WITH SELECTED EGGS AND JUST-HATCHED LARVÆ OF LASPEYRESIA MOLESTA BUSCK, LEESBURG, VIRGINIA, 1919

Insecticide	Formula	Total number of eggs employed	Total number	Per cent
			of eggs not hatching, (and in arsenical combinations) larvæ dead 30 hours after hatching	
1. Arsenate of lime, powder Nicotine sulphate (40%) Sea moss.	½-50 1-800 4-50	44	44	100 00
2. Nicotine sulphate (40%) Sea moss	1-800 4-50	587	560	95 40
3. Arsenate of lead, paste Nicotine sulphate (40%) Calcium (3), casein (1)	2 50 1-800 1-50	353	296	83 85
4. Arsenate of lime, powder Self-boiled lime sulphur Nicotine sulphate (40%) Sea moss	½-50 8-8-50 1-800 4-50	62	41	66 12
5. Nicotine sulphate (40%) Calcium (3), casein (1)	1-800 1-50	484	257	53 08

A study of selected unsprayed eggs as check showed that only 8.9 per cent failed to hatch.

TESTS WITH SINGLE CAGED PEACH TREES IN AN ORCHARD

Equally encouraging results have been obtained in limited field tests, in which applications were made to two-year-old infested peach trees enclosed in cages. These trees, from three to four feet in height, had been pruned back well, resulting in an abundance of growth and foliage, which proved an attractive feeding-ground for the first brood larvæ of the moth. On June 23, after cessation of feeding by second brood larvæ, a count was taken of the total number of twigs per tree, also the total number of injured twigs per tree. The percentage of injury based on these counts is given in Table II. 28.34, the average per cent of injury for the entire plot corresponds very nearly with the amount of injury usually found in infested peach trees throughout the infested area of northern Virginia. On June 14, while egg-laying was in progress, applications were made of several insecticides, the results with nicotine and nicotine combinations only being included here.

On July 30, after cessation of feeding by third brood larvæ, percentages of injury were ascertained again by count of infested twigs, the average being 13.38.

The reductions in the amount of injury recorded range from 13.34 to 44.44 per cent; the average reduction for the entire plot was 14.96 per cent. The average percentage efficiency for these insecticides may be computed as 73.3. Nicotine sulphate (40 per cent) and sea moss, arsenate of lime, powder, self-boiled lime sulphur, nicotine sulphate (40 per cent) and sea moss, as two individual combinations show each an efficiency of 80.0 per cent.

TABLE II.—RESULTS WITH NICOTINE AND NICOTINE COMBINATIONS IN FIELD TESTS WITH SINGLE CAGED PEACH TREES INFESTED BY LASPEYRESIA MOLESTA BUSCK, VIENNA, VIRGINIA, 1919

Sprays applied July 14		Per cent injury, June 23	Per cent injury, July 30	Per cent reduction in injury	Per cent efficiency for spray
Insecticide	Formula				
1 Arsenate of lead, paste Nicotine sulphate (40%) Sea moss	2-50 1-800 4-50	20 00	6 66	13 34	66.7
2 Arsenate of lead, paste Nicotine sulphate (40%) Calcium (3) casein (1)	2-50 1-800 1-50	40 00	13 33	26 67	66 6
3 Nicotine sulphate (40%) Sea moss	1-800 4-50	23 80	4 76	19 04	80 0
4 Arsenate of lime, powder Self-boiled lime sulphur Nicotine sulphate (40%) Sea moss	½-50 8-8-50 1-800 4-50	55 55	11 11	44 44	80 0
Check—no treatment		25 00	25 00	Unchanged	

STATEMENT OF RESULTS

Nicotine sulphate (40 per cent) diluted 1 part to 800 parts of water employed either alone as an ovicide or in combination with an arsenical in applications near hatching time has, in detailed laboratory tests and in limited field tests with single infested caged peach trees, resulted in a more than three-fourths control of *Laspeyresia molesta* Busck. These encouraging results are yet to be confirmed by experiments on an orchard scale.

Life-history studies show that in northern Virginia the heaviest deposits of eggs are present on the foliage about May 17, June 21, July 26 and August 28. Local applications of nicotine sulphate to be most effective should be made on or near these dates.

AN INTERESTING CASE OF MILK CONTAMINATION[1]

C. S. Spooner

The article by Prof. W. A. Riley, '18, on the presence of dipterous puparia in certified milk, recalls an instance of the occurrence of a dipteron in milk which came to my attention in Georgia while employed by the Georgia State Board of Entomology.

In January of 1914, a sample of milk was sent to the office of the state entomologist containing dipterous larvæ and puparia. The material was turned over to me for rearing. The second day after receipt, adults emerged. They proved to be a species belonging to the family Phoridæ.

The milk was still sweet when received and, as the adult flies emerged in so short a time, it is doubtful if the flies oviposited in the milk. A considerable quantity of dirt was present in the milk and it is probable that the larvæ entered along with the dirt and that the occurrence was accidental. They were able to obtain the necessary subsistence from the milk however, and all the larva present formed puparia and eventually emerged. Unfortunately the source of the milk was never investigated.

Material was sent to Mr. J. R. Malloch of the Illinois State Natural History Survey, to whom the writer is indebted for the determination. The species was *Aphiochaeta scalaris* Tw. Mr. Malloch further stated that *Aphiochaeta ferruginea* Brunetti is a synonym of the above species.

Malloch, '13, states that the larvæ have been recorded as attacking onions in the West Indies, living on decayed insects in Brazil and parasitizing *Hyphantria cunea* in Florida. Brunetti, '12, under the name *Aphiochaeta ferruginea*, states that the larvæ are known to cause myiasis of the intestine in man and that it is able to complete its life cycle in the intestine.

Brues, '15b, describes his experience in rearing the species from skin scraped from the back of a Negro who was suffering from a skin disease known as caraate. This author has no proof that it is the causal organism or even a normal secondary parasite. Mr. Brues cites Heuser, '10, who bred the species from larvæ which had been removed from an Indian's foot.

Perhaps an added proof of the synonymity of *Aphiochaeta scalaris* and *A. ferruginea* is the fact that Brues, '15b, under his description of *A. ferruginea,* refers to a figure in the report proper (Brues, '15a) and that this figure is labelled *A. scalaris!*

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[1] Contributions from the Entomological Laboratories of the University of Illinois, No. 61.

From the above citations it will be seen that the species has a very wide distribution and a remarkable diversity of larval habitat. The presence of this insect in milk suggests a possible method of its reaching the human intestine. Its occurrence in this country offers another reason, if such be needed, for safeguarding our milk supply.

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THE OCCURRENCE OF THE CHINCH-BUG (BLISSUS LEUCOPTEROUS) IN EASTERN MASSACHUSETTS

By Geo. W. Barber, *U. S. Bureau of Entomology*

The Chinch-bug is so little thought of as a serious pest in New England that an account of its destructive occurrence in that section may not be without interest.

On August 12, 1919, the writer's attention was first directed to the occurrence of this insect in Massachusetts. A visit was made to the Frick estate in Beverly, where the insect had first been discovered.

The Frick estate adjoins the sea and contains small natural wooded areas, dense groupings of shrubs and flowers, and lawns extending over a considerable area. It was found that the beautiful lawn of the estate had been entirely destroyed over an extent of several acres by the insect which was then present in great numbers as adults and nymphs of all stages. The lawn had been composed principally of blue grass, and this appeared to be the principal food of the insect, clover, weeds, and the coarser grasses being for the greater part untouched and the only green vegetation remaining.

Adults were already seeking winter quarters and were found in the collected leaves protecting the roots of shrubbery, and in the leaf mold in the wooded areas. The insect was generally very numerous throughout the estate even on buildings and fences, in some corners of the latter being upwards of an inch deep. A few were found in adjoining estates but the infestation seemed to be almost wholly confined to the Frick estate. A less serious infestation was found on the Tucker estate in Manchester, some two miles distant. Here the insect had destroyed small areas of the lawn which appeared as brown spots a few feet in diameter. The insect was not found between these two estates.

It has been suggested that sheep manure procured from an unknown

source in the West and which was used extensively on the lawns of these estates may have been the means of introducing the insect.

It is more probable, however, that the destructive infestation was due to the insect hibernating in large numbers during the winter of 1918–19 which was very mild in this section, whereas in the normal more severe winter very few survive.

On January 7, 1920, the lawn of the Frick estate had been burned and plowed and put in condition for spring planting, all leaves and débris about shrubs and in the wooded areas had been collected and burned and replaced by uninfested material. The adults were, however, hibernating in considerable numbers in the roots of certain clump grasses, but it is doubtful if these will give sufficient protection for the insect to survive in numbers great enough to become injurious next season.

Scientific Notes

Hessian Fly and History. The Billop house at Tottenville, Staten Island, one time the headquarters of General Howe, who gained an undesirable notoriety as commander of the Hessians, is being fitted up with machinery for the manufacture of insecticides, we are informed by Mr. M. T. Smulyan. The Hessians are supposed to have been the unintentional introducers of the Hessian fly and it is certainly a most interesting coincidence that the headquarters of their commander should at this late date be transformed into an insecticide plant.

New Gipsy Moth Colonies. Two new gipsy moth colonies outside the known infested area, were reported during the month of July, one at Somerville, N. J., by Mr. Harry B. Weiss, State Inspector, and the other at Brooklyn, N. Y., by Mr. George G. Atwood, of the Department of Farms and Markets, Albany, N. Y.

The caterpillars were nearly full grown at the time the reports were received by the Bureau of Entomology, but scouts have been detailed to examine the territory to determine the extent of the infestation, after which control measures will be put in force. A. F. B.

A European Pest Found in Massachusetts. The Satin Moth (*Stilpnotia salicis* Linn.), has recently been found in Medford, Mass. This insect is closely related to the gipsy moth and the brown-tail moth. The larvæ feed on poplar, willow and other trees. In the area where the worst infestation was found, some poplar trees were defoliated and others were partially stripped. The insect was not discovered until the larvæ were nearly full grown, and it was too late to spray effectively. Large numbers of the caterpillars and pupæ have been crushed and egg clusters treated with creosote, so that the infestation at this point has been materially reduced.

The work has been carried on in the area controlled by the Metropolitan Park under the direction of Mr. A. N. Habberley, Superintendent of the Middlesex Fells Reservation, and adjoining property has been treated by agents of the Massachusetts State Forester. Assistants of the Bureau of Entomology have conducted scouting work in the vicinity and in the adjoining towns, and at present infestations have been found in twenty-seven towns. Observations on the life-history, habits, and information concerning control, is being secured by assistants at the Gipsy Moth Laboratory, Melrose Highlands, Mass. A. F. B.

JOURNAL OF ECONOMIC ENTOMOLOGY

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A bulletin just issued by the National Research Council lists more than three hundred laboratories maintained by industrial concerns in America, in which fundamental scientific research is carried on. The bulletin gives a brief account of the personnel, special equipment and particular kind of research carried on in each of the laboratories listed. Industrial research laboratories have increased notably in number and activity, both in America and Great Britain, since the beginning of the War, because of the lesson vividly taught by the war emergency. It was only by a swift development of scientific processes that the Allies and America were able to put themselves in a position first to withstand and then to win a victory over Germany's science—backed by armies and submarines. And it is only by a similar and further development that America and the Allies can win over Germany in the economic war-after-the-war, now being silently but vigorously waged.

The above applies to all sciences and in this advance entomology must take its place. The preliminary steps recently taken in relation to a Plant Protection Institute promises much in the way of more fruitful investigation and more effective coöperation not only among entomologists but between them and those engaged in related sciences. There is greater need than ever for the highest type of coördinated investigation and demonstration if we are to meet in full obligations laid upon us by present day conditions.

Obituary

WILBUR ROSS McCONNELL

The death of Professor W. R. McConnell, which occurred on June 23 last, at Carlisle, Pennsylvania, deprived the Federal Bureau of En-

tomology of the services of one of its most brilliant, able, and amiable young entomologists.

Wilbur Ross McConnell was born at Whitesburg, Pa., in 1881. The basis of his education was secured in the public schools at that place. He graduated from the Pennsylvania State Normal School at Indiana, in 1900, and from the Pennsylvania State College in 1906, with the degree of B. S. specializing in zoölogy and entomology. Professor McConnell took a special course in zoölogy at Cornell University in 1908, and received his M. S. from Pennsylvania State College in 1910.

After matriculation Professor McConnell served as Scientific Assistant in the Division of Zoölogy of the Pennsylvania State Department of Agriculture at Harrisburg, Pennsylvania, where he conducted researches regarding the animal foods of native reptiles, and especially the snakes and turtles of Pennsylvania. The results of these studies have been published in the bulletin of the State Division of Zoölogy. In the fall of 1907 Professor McConnell was appointed Assistant Professor of Zoölogy and Entomology at the Pennsylvania State College, and placed in charge of the Department. His work in this capacity was very successful, as shown by the character of his graduates, a considerable number of whom are among the most successful investigators in Federal and State employ.

In 1912 Professor McConnell was appointed Scientific Assistant in the Federal Bureau of Entomology, and assigned by the late Professor Webster to the study of the fall army worm in the lower Mississippi Valley. Shortly afterward he was placed in charge of an entomological field station at Greenwood, Mississippi, where he remained for about one year. While there he conducted with marked ability investigations of the parasitic enemies of the fall army worm and insects attacking the leguminous forage crops. Professor McConnell's work at Greenwood was terminated prematurely by an attack of illness, from which he never fully recovered. The summer of 1914 was spent in the investigation of the insect enemies of forage crops in the southwestern states, and in the fall of that year he was placed in charge of a field laboratory at Hagerstown, Maryland, with the investigation of the Hessian fly as his major project. In this work he made especial progress in the study of the Hymenopterous parasites of the insect. These studies were transferred to Carlisle, in 1917, where he was deeply immersed in research when stricken by fatal illness.

Professor McConnell's additions to our knowledge of the insect parasites of the Hessian fly are numerous and valuable. Several species new to science were discovered by him and the list of parasites of the Hessian fly in America was enriched from some half dozen or more to at least thirty species. Professor McConnell had chosen as his special

field the determination of the effect of these parasites on the abundance and the periodical outbreaks of the host. With this idea in view he had made an exhaustive study of the factors bearing upon the rate of multiplication of the insect, a summary of which will soon appear in print.

Professor McConnell was the possessor of a broad, thorough training in zoölogy and general natural history, which permitted him to approach his problems in a big way. He was an indefatigable worker, and most deeply interested in his work. This led to the overdraft of his reserve powers, already reduced by previous illness, and there is no doubt in the minds of his associates that his life was sacrificed to entomological research.

Professor McConnell was a member of the Entomological Society of America, the American Association of Economic Entomology, the American Association for the Advancement of Science, and the Entomological Society of France. W. R W.

Reviews

Orthoptera of Northeastern America with Especial Reference to the Faunas of Indiana and Florida. By W. S. Blatchley. The Nature Publishing Company, Indianapolis, 784 pages, 246 text figures and 7 plates, with bibliography, glossary and index, 1920.

As stated by the author, this book has been prepared to supply the long-felt need of a single comprehensive manual on the Orthoptera inhabiting the United States east of the Mississippi River and Canada east of the 90th Meridian. Hitherto the student working in this group has been compelled to resort to a large number of special publications—many of them out of print or difficult to obtain—in order to get the descriptions to enable him to determine the species he may have collected or the information he may have desired regarding their habits or distribution. During the last two decades, as a result of the extensive investigations of Rehn and Hebard, Caudell, Morse, Davis and other workers, most of the problems connected with the nomenclature of the group have been cleared up and the limits of the different species, with few exceptions, clearly defined. There seems to be every reason to believe that the vast majority, if not all, of the Orthoptera of the Eastern States are now known, and one can therefore heartily agree with the author when he states that he deems the time propitious for the appearance of a work of this kind.

The present work is an outgrowth or expansion of the authors' earlier work, "Orthoptera of Indiana," issued in 1903. In the preparation of the book the author states that he has "ever had in mind the needs of the tyro and not those of the specialist in Orthoptera, the primary object in view being a simple work which would enable beginners in the most direct way possible to determine the scientific names and arrange and classify the Orthoptera in their collections." For this reason keys "based on the more salient or easily recognizable characters separating the divisions to which they pertain" have been made an important feature of the book. In the judgment of the reviewer the book is admirably adapted for this pupose. It puts for the first time at the disposal of those who are not specialists in Orthopteran taxonomy the means for ascertaining the species of Orthoptera with which they may happen to be

concerned, as well as supplying additional information which could otherwise be obtained only after much sacrifice of time and effort. To the amateur, the entomological beginner, the field naturalist, the economic entomologist, the cytologist, and others who may be dealing with Orthopteran material, but are not specialists in the group, a work such as the present one ought to be of the greatest service. The reviewer vividly recalls the help and inspiration which in his earlier studies of Orthoptera he derived from the use of Professor Blatchley's Orthoptera of Indiana, which in spite of its limited applicability was the only work of a comprehensive nature obtainable at the time. The present work with its inclusion of the entire eastern fauna and its "up-to-dateness" is naturally vastly superior to the earlier work on the Indiana fauna, and the reviewer therefore feels himself justified in predicting for it an increasing popularity and a wide field of usefulness in arousing interest in Orthoptera or in subjects connected with them.

There is one error in the book to which the reviewer desires to call attention, as it is possible that he may be partly responsible for it. On page 558 the record credited to the reviewer from Morristown, N. J., should be Moorestown, N. J. This error may have been typographical, or it may have been due to a misreading of the reviewer's label attached to the specimen sent to Professor Blatchley.

HENRY FOX

Current Notes

Conducted by the Associate Editor

Dr. E. D. Ball, state entomologist of Iowa, was appointed June 12 by President Wilson as Assistant Secretary of Agriculture.

Major General William C. Gorgas, who was appointed a member of a commission sent to West Africa to investigate sanitary conditions, suffered a stroke of apoplexy in London, May 31 and died July 3.

At the North Carolina State College, Mr. Herbert Spencer has been promoted from instructor to assistant professor of Zoölogy and Entomology and Mr. J. H. Williams from assistant to instructor in Zoology and Entomology.

Professor Z. P. Metcalf, professor of Zoölogy and Entomology, North Carolina State College, and Entomologist, North Carolina Experiment Station, was elected President of the North Carolina Academy of Science at the last annual meeting.

Professor Herbert Osborn of the Ohio State University will spend two months at the Forest Camp of the New York State Forestry School, located at Cranberry Lake in the Adirondack forest, investigating forest insects, expecially Hemiptera of the region.

The honorary degree of Doctor of Science was conferred upon Wilmon Newell, president of the American Association of Economic Entomologists, and Plant Commissioner of Florida, by Iowa State College at its semi-centennial celebration in connection with commencement in June.

Early in May W. H. Lyne, provincial inspector at Vancouver, B. C. found some suspicious looking larvae in the soil surrounding the roots of maple and Thuya seedlings from Japan. The larvae were forwarded to Mr. J. J. Davis in charge of the Japanese Beetle Investigations in New Jersey, for identification. Mr. Davis reported them as not being the larvae of the Japanese beetle but a closely allied species.

Dr. L. O. Howard attended the Imperial Entomological Conference held in London, early in June. *Nature* states that "much gratification was felt and expressed at the presence for the first two days of Dr. L. O. Howard, entomologist of the U. S. Department of Agriculture. His brief pointed remarks at some of the discussions were much appreciated; he deplored some recent attempts to destroy "entomology" as a specific

economic subject by dividing its subject matter between "parasitology" and "phytopathology."

According to *Entomological News*, Mr. Harry B. Weiss, on May 1, was appointed chief of the Bureau of Statistics and Inspection, New Jersey Department of Agriculture, to fill the vacancy caused by the death of Franklin Dye.

Mr. Irving W. Davis, Connecticut Agricultural Experiment Station, who for nearly seven years has served as assistant entomologist and deputy in charge of gipsy and brown-tail moth work in Connecticut, resigned June 8, to enter the banking business. He will remain in Danielson, Conn., where he has had headquarters for four years.

According to *Science*, Mr. E. P. Van Duzee, curator of Entomology, in the California Academy of Sciences and Dr. E. C. Van Dyke, of the University of California, who attended the annual meeting of the Pacific Division of the American Association for the Advancement of Science in Seattle, will remain for a month in the state of Washington for field work. Mr. Van Duzee, who specializes in the Hemiptera, has in his collection and that of the California Academy of Sciences, probably the most representative collection of Hemiptera in America. Dr. Van Dyke will collect Coleoptera in which he is a specialist.

The following appointments have been made to the staff of the Entomological Branch, Canadian Department of Agriculture: Mr. H. W. Crosbie, temporary seasonal assistant, Division of Forest Insects from May 15; Mr. J D. MacFarlane, temporary seasonal assistant, Division of Forest Insects, from May 25; Professor A. V. S. Pulling, seasonal entomologist, Natural Control Investigations from May 15; Mr. G. M. McFarlane, temporary Junior Entomologist at Saskatoon, Sask., from May 1; Mr. H. A. Robertson, temporary Junior Entomologist at Treesbank, Man., from May 15; Miss A. C. Healey, temporary clerk-stenographer at Vernon, B. C., from May 15. Messrs. Crosbie, MacFarlane and Pulling will be engaged on the spruce budworm investigations with headquarters at Fredericton, N B.

According to *Science*, the official delegates to the Imperial Entomological Conference which opened in London, June 1, were as follows:—Canada and South Africa, Mr. C. P. Lounsbury; Australia, Professor R. D. Watt; New Zealand, Dr. R. J. Tillyard; India, Mr. C. F. C. Beeson; Queensland, Mr. F. Balfour Browne; British Guiana, Mr. G. E. Bodkin; Ceylon, Mr. F. A. Stockdale; East Africa Protectorate, Mr. T. J. Anderson; Federated Malay States and Straits Settlements, Mr. P. B. Richards; Gold Coast, Mr. W. H. Patterson; Imperial Department of Agriculture for the West Indies and Leeward Islands, Mr. H. A. Ballou; Mauritius, Mr. G. A. Auchinleck; Northern Rhodesia, Mr. R. W. Jack; Seychelles, Dr. J. B. Addison; Sierra Leone, Mr. H. Waterland; Sudan, Mr. H. H. King; Trinidad, Mr. F. W. Ulrich, and Uganda, Mr. C. C. Gowdey.

With the advice and assistance of the National Research Council, a coöperative body of scientific experts on injurious insects and plant diseases and of manufacturers of insecticides, fungicides and general chemicals and apparatus used in fighting the enemies of field and orchard crops, has just been organized under the name of the Plant Protection Institute. The purpose of the institute is to promote the general welfare by supporting and directing scientific research on the pests of crops, shade trees and ornamental plants, and on the methods of their control, and by furthering coöperation between the scientific investigators and the manufacturers of chemicals and appliances, especially for the sake of effecting standardization and economy in the production and use of the means of fighting pests. Also it expects to aid in the dissemination of scientifically correct information regarding the control of injurious insects and plant diseases. Much excellent work along this line is now being done by government and state organizations, but a further advance can be made by introduc-

ing a wider coördination and coöperation of the efforts of both the scientific men and the manufacturers of control devices. It is in this general direction of coöperative work that the Plant Protection Institute expects to be most active.

The Department of Zoölogy and Entomology, North Carolina State College is making an addition to its present building. The addition consists of two parts, a service building and an insectary. The service building will contain an underground pit for the study of subterranean insects, a potting room, a small apiculture laboratory and a laboratory for advanced students in entomology. The insectary is of modified greenhouse construction with solid roof to obstruct the direct rays of the sun. It is divided into three sections, two of which are enclosed by glass and heated, and one enclosed by screening and not heated.

Five field parties have been organized for the spruce budworm investigations in New Brunswick; these will be in charge of Messrs. Gorham, Kinghorn, Pulling, Simpson and Dunn. Professor Pulling is professor of Forestry at the University of New Brunswick and Mr. Kinghorn has been transferred to this survey by the Provincial Crown Lands Department. Four parties will proceed to Nictau Lake where a headquarters camp will be erected. The fifth party will use Juniper as their headquarters. Mr. Dustan has started a series of experiments on the natural control of the green apple bug at Wolfville, N. S.

On May 24 an amendment to the regulations under the Canadian Destructive Insect and Pest Act was passed by Order in Council prohibiting the importation of corn and broom corn, celery, green beans, beets, spinach, rhubarb, oat and rye straw, cut flowers of chrysanthemums, asters, cosmos, zinnias, hollyhocks, gladiolus and dahlias from the towns infested with the European Corn Borer in the states of Massachusetts, New Hampshire, New York and Pennsylvania, unless the same are accompanied by a certificate of inspection issued by the Federal Horticultural Board. The amendment dealing with this pest and passed May 19, 1919, is rescinded.

Professor W. B. Herms of the University of California has established a temporary summer laboratory in the Sacramento Valley near Vina, Tehama County, Cal., for the purpose of investigating certain malaria-mosquito problems in that vicinity, notably factors governing breeding habits of anophelines, their egg laying habits and per cent of infection. Three species of anophelines are present; namely, *A. occidentalis* (western variety of *A. quadrimaculatus*) *A. punctipennis* and *A. pseudopunctipennis* together with a prevalence of malaria. Collaborating with Professor Herms is Professor S. B. Freeborn, also of the University of California and a small group of students. The present intensive investigation follows a general malaria-mosquito survey of California which was completed last summer.

The National Research Council, a cooperative organization of leading scientific and technical men of the country for the promotion of scientific research and the application and dissemination of scientific knowledge for the benefit of the national welfare, has elected the following officers for the year beginning July 1, 1920:—Chairman, H. A. Bumstead, professor of Physics and Director of the Sloane Physical Laboratory, Yale University; First Vice-Chairman, C. D. Walcott, president of the National Academy of Sciences and Secretary of the Smithsonian Institution; Second Vice-Chairman, Gano Dunn, president of the J. G. White Engineering Corporation, New York; Third Vice-Chairman, R. A. Millikan, professor of Physics, University of Chicago; Permanent Secretary, Vernon Kellogg, professor of Biology, Stanford University; Treasurer, F. L. Ransome, treasurer of the National Academy of Sciences. The Council was organized in 1916 under the auspices of the National Academy of Sciences to mobilize the scientific resources of America for work on war problems, and reorganized in 1918 by an executive order of the president on a

permanent peace-time basis. Although coöperating with various government scientific bureaus it is not controlled or supported by the government. It has recently received an endowment of $5,000,000 from the Carnegie Corporation, part of which is to be expended for the erection of a suitable building in Washington for the joint use of the Council and the National Academy of Sciences. Other gifts have been made to it for the carrying out of specific scientific researches under its direction.

According to *Science*, Dr. Frank E. Lutz of the American Museum of Natural History, of New York City, has started on the third of a series of expeditions planned to trace the distribution of insect life in the western part of the United States. The first of these expeditions collected in the Santa Catalina Mountains and the deserts of southern Arizona; the second—made last year,—worked in the Colorado Rockies. This year special attention will be paid to regions north and west of Colorado.

INFORMAL CONFERENCE AND FIELD MEETING OF EASTERN ENTOMOLOGISTS

The meeting called to order 10.30 a. m., July 29, 1920, at Philadelphia in the rooms of the Academy of Natural Sciences of Philadelphia. A. F. Burgess was elected chairman and J. J. Davis secretary of the meeting.

The chairman appointed the following committees:

Nominating Committee: Robert Matheson, A. L. Quaintance and J. L. King.

Resolutions Committee. E. P. Felt, J. G. Sanders and H. B Weiss.

The forthcoming Bibliography of Economic Entomology was discussed by Messrs. Burgess and Felt. Members were urged to immediately subscribe for this Bibliography and to secure as many additional subscriptions as possible to ensure sufficient support for the publication.

The remainder of the morning session was taken up in a discussion of the present fruit insect situation which was led by A. L. Quaintance.

In the afternoon the members visited the Japanese beetle laboratory at Riverton, N. J., where they had an opportunity to note the investigations being conducted and the damage caused by the beetle.

An informal meeting at the Vendiz Hotel, Philadelphia, was occupied by a full discussion of the Japanese beetle problem. The work was explained by Messrs. Quaintance, Davis, Stockwell and Hadley and discussed by a number present.

The session was resumed at 9.30 a. m., July 30, in the rooms at the Academy of Natural Sciences.

The work and present status of the European corn borer was fully explained by Messrs. Worthley, Felt, and Caffrey and discussed by a number present.

The discovery in Massachusetts of a new European caterpillar pest of poplar and willow, commonly known as the Satin moth, was reported by A. F. Burgess.

Messrs. Burgess and McIntyre also explained the Gipsy moth situation, particularly the new discoveries of the pest in New Jersey and New York.

The nominating committee made the following recommendations: Chairman, Dr. W. E. Britton; Secretary, Dr. T. J. Headlee.

The recommendations were adopted.

The committee on resolutions submitted the following:

Whereas, We, a group of Entomologists of the North Eastern United States, assembled at Philadelphia, Pa., in an informal conference and field meeting, hereby record our conviction that the presence of certain introduced insects in various parts of the country constitutes a serious menace to our material welfare, Therefore be it

Resolved.—That the control work against the Japanese beetle is hereby heartily approved and that those in charge be urged to enlarge and extend the work already

under way in the development of a satisfactory insecticide and that no efforts be spared in pushing the search for natural enemies here and abroad.

Resolved.—That the establishment of the Gipsy moth over a considerable area remote from the previously known infested territory is most unfortunate and that the situation demands adequate appropriations by Congress for the speedy extermination of the pest in these newly infested areas and for a continuance of the effective repressive measures in New England.

Resolved.—That the European corn borer must be regarded as potentially a very dangerous insect and in view of its wide distribution, prevention of further spread and large scale determination of effective control methods are especially important, and because the situation is so complex there is special need of the closest coöperation between federal and state authorities.

Resolved.—That in view of the presumable importance of natural enemies in the control of certain of these pests and the very great differences in habits and requirements of these beneficial insects, we earnestly recommend that the work of importation be enlarged and the sending to foreign countries of several specialists in their respective lines.

And be it further *Resolved.*—That this informal branch meeting has been most encouraging and profitable and we therefore recommend the establishment of an Eastern Branch of the American Association of Economic Entomologists.

Resolved.—That we express our thanks to President Wilmon Newell for his encouraging and decisive letter addressed to this meeting in consequence of his enforced absence from the sessions.

Resolved.—That our most sincere thanks be extended to The Academy of Natural Sciences for the courtesies extended and to Mr. J. J. Davis for making such excellent provision for the meetings both in Philadelphia and at Riverton. Furthermore, we would recognize the generous assistance of citizens of Riverton.

E. P. Felt
J. G. Sanders
H. B. Weiss

The above resolutions were unanimously adopted.

The following is a list of those present: E. D. Ball, Washington, D. C.; P. T. Barnes, Harrisburg, Pa.; Theo. L. Bissell, Torresdale, Pa.; A. F. Burgess, Melrose Highlands, Mass.; D. J. Caffrey, Arlington, Mass.; E. L. Chambers, Washington, D. C.; A. B. Champlain, Harrisburg, Pa.; C. W. Collins, Melrose Highlands, Mass.; E. N. Cory, College Park, Md.; E. M. Craighead, Harrisburg, Pa.; E. T. Cresson, Jr., Philadelphia, Pa.; S. S. Crossman, Melrose Highlands, Mass.; J. J. Davis, Riverton, N. J.; D. M. DeLong, Harrisburg, Pa.; E. P. Felt, Albany, N. Y.; D. E. Fink, Riverton, N. J.; F. W. Foster; Henry Fox, Riverton, N. J.; S. W. Frost, Arendtsville, Pa.; T. L. Guyton, Harrisburg, Pa.; C H. Hadley, Riverton, N. J.; E. A. Hartley, Oak Lane, Pa.; T. J. Headlee, New Brunswick, N. J.; P. H. Herzog, Hightstown, N. J.; V. G. Hipple, Riverton, N. J.; H. E. Hodgkiss, State College, Pa.; W. O. Hollister, Kent, O.; J. L. Horsfall, Bustleton, Pa.; J. L. King, Harrisburg, Pa.; H. B. Kirk, Harrisburg, Pa.; J. N. Knull, Hummelstown, Pa.; M. D. Leonard, Ithaca, N. Y.; Robert Matheson, Ithaca, N. Y.; H. L. McIntyre, Melrose Highlands, Mass.; Alvah Peterson, New Brunswick, N. J.; J. K. Primm, Oak Lane, Pa.; A. L. Quaintance, Washington, D. C.; J. G. Sanders, Harrisburg, Pa.; J. D. Sherman, Mt. Vernon, N. Y.; J. R. Stear, Chambersburg, Pa.; C. W. Stockwell, Riverton, N. J.; F. M. Trimble, West Chester, Pa.; R. T. Webber, Melrose Highlands, Mass.; C. A. Weigel, Washington, D. C.; H. B. Weiss, New Brunswick, N. J.; F. H. Worsinger, Jr., Torresdale, Pa.; and L. H. Worthley, Boston, Mass.

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(Continued from p. 363)

PAPERS READ BY TITLE

THE PACIFIC OAK TWIG-GIRDLER[1]

By H. E. Burke, *Specialist in Forest Entomology, Forest Insect Investigations, Bureau of Entomology, U. S. Department of Agriculture*

Economic Importance

One of the most important and characteristic native shade trees of the coast valleys of California is the California live oak (*Quercus agrifolia* Nee). As a general rule this fine tree is in a healthy and vigorous condition, but sometimes it is attacked by various insects, which give it a ragged and unsightly appearance. One of the most important of these insects is the twig-girdler. Both small and large trees sometimes are thickly spotted with small areas of fading, yellow, red or brownish foliage which stands out strikingly against the normal green of the healthy leaves. In the majority of cases the dead twig or small branch bearing the coloring leaves will show at its base the characteristic spirally-winding mine of the twig-girdler. Sometimes so many twigs and small branches are killed by the girdler that the tree dies. In any case, the ragged appearance caused by numbers of dead and dying twigs seriously injures the tree for ornamental purposes.

History and Identity

The species was described by Dr. George H. Horn in 1891, with host plant unknown. (Trans. Amer. Ent. Soc., Vol. XVIII, p. 298.)

[1] *Agrilus angelius* Horn, family Buprestidæ, order Coleoptera.

Doane mentioned the work on the live oak in 1912 without naming the species. (Jour. Econ. Ent., Vol. 5, p. 347.) Childs, in 1914, gave a very good account of the insect and its work under the name of *Agrilus politus* Say. (Month. Bul. Cal. State Com. Hort., Vol. III, pp. 150–5.) He also figured the insect and its work and recommended methods of control. Essig, in 1915, figured the insect and gave a short account of the life history, work, distribution, food plants, control and natural enemies under the name *Agrilus politus*. (Injurious and Beneficial Insects of California, p. 234.) In January, 1917, Burke figured the eggs as those of *Agrilus angelicus* (U. S. Dept. Agric., Bul. 437, fig. I, Pl. IX) and in June of the same year gave a short account of the species under the same name. (Jour. Econ. Ent., Vol. 10, p. 330.)

Specimens have been sent to the leading specialists on the genus Agrilus and there seems no doubt but that the species is *angelicus* Horn. It is quite distinct from *politus* Say. A very similar species which has been identified as *angelicus* by some of the specialists lives in the manzanita (*Arctostaphylos* species) and the madrone (*Arbutus menziesii*) in the Sierras and coast valleys of Central California. There are some differences in the life history which cause the writer to believe that it is distinct. Experiments are now being carried on which should settle this point.

Distribution and Food Plants

The specimens from which the species was named came from near Los Angeles and from the Santa Cruz Mountains, California. Childs obtained his specimens at Palo Alto from the live oak. Essig says that the insect is found throughout the state of California, that the favorite host is the willow, that the live oak often is severely damaged by its attacks and that other food plants are the buckeye and hazelnut. He undoubtedly used the distribution and food plants of *A. politus*, under which name he accounts for the species.

The writer has reared specimens of the beetle from live oak twigs collected at Pasadena by Dr. A. G. Smith, and at Palo Alto, Los Gatos, Laurel and near Saratoga, Calif., by himself. Larvæ and the characteristic work have been found at Boulder Creek, San Juan, Monterey, Carmel, Woodside, Niles, Alum Rock, Napa and Mt. St. Helena, by Mr. R. D. Hartman. Mr. F. B. Herbert found the work very common at Montecito near Santa Barbara and at South Pasadena. During the past summer heavy infestations were found in the black oak and canyon live oak near Confidence, Tuolumne County, in the middle Sierras.

The following host plants have been determined: California live oak (*Q. agrifolia*), interior live oak (*Q. wislizeni*), leather oak (*Q.*

durata), canyon live oak (*Q. chrysolepis*), engelmann or mesa oak (*Q. engelmanni*), California black oak (*Q. californica*) and the tan oak (*Q. densiflora*).

The species range from a few feet above sea level to an altitude of 6,000 feet.

Characteristic Work

The first indication of an attack by the twig-girdler is scattering small patches of fading foliage. Other insects and diseases cause somewhat similar dying branches, but the trained eye usually can detect the difference. Roundheaded borers kill larger branches and their work is not so common, scales of the genus Kermes and some of the gall wasps kill smaller twigs, and a disease supposed to be related to the chestnut blight kills large patches of foliage on adjoining branches. Childs says that the foliage that dies from the girdler work is a light straw color when dry, while that killed by the disease is a distinctive reddish brown tinge. These color differences may hold true in some cases, especially during the first year, but the girdler work of the second year is apt to cause good sized patches of reddish foliage which are difficult to distinguish from the disease work.

A close examination of the dying or dead twigs will always show the real cause of the trouble. If it is the girdler there will be a small mine winding around under the bark and down the twig. During the first year this only goes a few inches, but during the second it may go for a foot or more, sometimes two feet, the mine spiralling the branch and killing all of the twigs terminal to it. It may go down one fork and up another. The foliage on the killed twigs will vary from a fading green to a reddish brown, depending on the time of the year each was killed. Usually most of the mine is just under the bark, but it may go into the wood. It usually spirals around the branch from four to twelve times, but sometimes runs straight down for a long distance. Just before it is completed the mine usually reverses and runs back up the branch for an inch or more, where it goes into the wood and terminates in the slightly enlarged pupal cell. After the beetle emerges the pupal cell opens on the surface of the branch in the oval emergence hole. Most of the branches killed by the girdler are not over one half an inch in diameter. The leaves fall before the end of the second year and the work shows as a leafless branch, an unsightly blemish on a splendid object of natural beauty.

The Twig-Girdler

The twig-girdler is a slender, whitish flattened boring grub of the common agriloid type. It varies in length from 1 mm. when newly hatched to 18 mm. when full grown. The mouth parts and tail for-

ceps are dark brown or black. Hatching from the egg during June and July, the girdler starts mining through the bottom of the shell and under the bark. By the middle of the first winter it has grown to be 7 mm. long and has extended its mine down the small twigs for from one to three inches. Most of the twigs have been spiralled and the foliage has faded to yellow. At this time some of the girdlers are under the bark and some have gone into the wood. Mining is continued during the succeeding spring and summer until the second winter, when the girdler has mined down the branch for about 6 to 12 inches and has grown to about 15 mm. long. Most of the foliage is reddish brown or rusty looking. The girdler now goes into the wood and lies outstretched in the center of the branch for most of the winter. In the spring it continues down the branch under the bark for an inch or more and then turns and retreats back up for several inches before it again enters the wood and forms the pupal cell. In the Santa Clara Valley this takes place about the middle of May. The girdler is now full grown and it soon shortens up to about half its former length and gets ready to pupate. The pupal cell is usually formed at an angle to the surface of the branch, the mine entering the wood and angling up to the surface for the emergence of the beetle.

THE PUPA. The pupa when first formed is a delicate whitish object with the head, body, wings and legs faintly indicated. It is about 7 to 9 mm. long and 1 to 2 mm. broad. The eyes soon commence to darken and in about two weeks all of the head, thorax and underside of the body have changed to a brownish bronze. The wings and elytra, which are folded on the breast and the dorsal surface of the abdomen, remain white. Upon the transformation of the pupa to the beetle which now takes place the wings and elytra change to the back and the elytra soon take on the normal bronze color of maturity. This is done without going through the interesting color changes of some of the other species like *politus*. Most of the pupæ were found in the field during the last of May and the first of June. Some have been found in April.

THE BEETLE. The beetle is a slender brownish bronze insect with a coppery or slightly golden thorax. Its length is from 5 to 7 mm. and its breadth from 1½ to 2 mm. The males have dark green faces and the females brownish bronze ones. The claws are cleft in such a manner that the lower portion is turned inward and the hind tarsi; are stout and obviously shorter than the tibiæ. The newly formed beetle stays in the pupal cell for several days before it eats its way to the outer world. After this emergence, which takes place during May and June, the beetles fly around in the warm sun, feed on the edges of the leaves of the oaks and mate. Soon after mating the female lays

her eggs and both soon die. So far as could be determined, most of the beetles live about two weeks.

THE EGG. When first laid the egg is a dull white, flattened oval scale-like object $1\frac{1}{4}$ mm. long and $\frac{3}{4}$ mm. broad. It soon becomes darker with age and development and in from 4 to 5 days turns a shiny black. It is covered with a varnish-like covering which catches the dust, etc., so that in a week or more it looks like the brownish or blackish gray bark of the twigs. The egg is laid singly on the bark of the twig, near the end of the last year's growth. It is not tucked under a loose flake of the bark, or in a crevice, but is laid on the smooth bark, usually near the base of a small twig or a leaf scar. In the great majority of cases only a single egg is laid on a twig, but in a few cases two were observed close together and in one or two instances three were laid scatteringly along the stem. In hatching, the young larva bores into the bark through the bottom of the shell and packs the shell full of the borings. Most of the eggs are laid during the last of June and the first of July. All appear to hatch in from two to three weeks after they have been laid.

NUMBER OF GENERATIONS

The oak twig-girdler is a two-year species. Eggs laid in June of 1912, 1914 and 1916 produced beetles in 1914, 1916 and 1918. In many localities there is no brood of beetles during the alternate years. In some there are a few scattering individuals and in others there is a well-defined brood each year; that is, in June, beetles will be emerging from some twigs while year-old larvæ will be found in others; in January, eighteen-months old larvæ will be found in the large twigs and six-months old larvæ in the small ones. A most interesting occurrence was observed at Confidence, Tuolumne County, during August, 1919. All of the specimens found in the black oak were small larvæ from eggs laid in June, 1919, while all of those found in the canyon live oak were year-old larvæ from eggs laid in June, 1918.

NATURAL ENEMIES

Natural enemies undoubtedly play an important part in the life history of the twig-girdler. Nine species of Hymenopterous parasites were reared from the larval mines and pupal cells. One of these was a new species and new genus, and three others were new species. Messrs. S. A. Rohwer and R. A. Cushman identified the species and named the new ones.

Cryptohelcostizus rufigaster Cushman,[1] n. gen., n. sp., was reared several times from a single larva or cocoon found in the pupal cell of the girdler. Two *Cryptoideus fasciatus* Ashm. were reared from sim-

[1] Cushman, R. A., Proc., U. S. Nat. Mus., Vol. 55, pp. 534–35.

ilar pupal cells. *Doryctes maculipennis* Rohwer, n. sp., was reared from cocoons found in both the larval mines and the pupal cells. Another species of Doryctes was reared in numbers from cocoons found in the same places. In one locality near Palo Alto 50 per cent of the girdlers were parasitised by this species. Several cocoons occur packed in the same cell or mine. *Callihormius* sp. was reared from the larval mines and possibly the pupal cell.

Ptinobius agrili, Rohwer[1] n. sp., larvæ were found to emerge from prepupal girdler larvæ in the pupal cells and formed naked pupæ. Only a single one was found in each cell. *Metapelma spectabilis* Westwood was reared from the girdler-infested twigs. It may be a hyperparasite. *Tetrastichus anthracinus* Ashmead, a small black tetrastichid, was the commonest parasite reared. It occurred in numbers in the larval mines and pupal cells of the girdler. As many as seventeen larvæ were found in one girdler larva. Sometimes the girdler larva was killed before it made the pupal cell, and sometimes afterward. The Tetrastichus larvæ then emerged and formed naked pupæ in the mines or cells. *Dinotus agrili* Rohwer, n. sp., was reared several times from girdler-infested twigs sent in from Pasadena by Dr. A. G. Smith.

Methods of Control

The best method of control developed at the present time is the pruning of the infested twigs. This should be done in the spring about April first before the beetles emerge. At this time both the twigs infested for one year and for two years are easily distinguished and those infested for the two years must be treated if the infesting insects are to be killed before they emerge. As many of the infesting girdlers are parasitised, it is better not to burn the infested twigs but to cage them in a box or barrel with the side or top made of number 16 mesh wire screen. The beetles cannot get through this and will soon die, while the parasites will escape and attack the twig-girdlers in the infested twigs overlooked in the pruning.

Poison sprays used against caterpillars in the spring kill some of the beetles as they feed on the foliage before mating. Contact sprays used against scales and other bark pests may kill some of the eggs, but it is doubtful if it will pay to use either of these if fighting only the girdler.

FIELD EXPERIMENTS FOR THE CONTROL OF THE APPLE MAGGOT

By Glenn W. Herrick, *Ithaca, N. Y.*

In 1910 the writer urged Dr. J. F. Illingworth, then a graduate student at Cornell University, to undertake an investigation of the

[1] Rohwer, S. A., Proc. Ent. Soc. Wash., Vol. 21, pp. 5–8.

apple maggot with a view to its control by the sweetened poisoned baits which had been so successfully used for the control of the Mediterranean Fruit-fly in South Africa a few years previously. I pointed out that the insect had never been adequately controlled in this country and that if the poisoned baits proved effective here it would be a great boon to growers. The results of his work are found in Bulletin 324 of the Cornell University Experiment Station.

Illingworth's demonstration that the insect could be effectively controlled by the use of poisoned baits, sweetened or unsweetened, has now been substantiated by experimental evidence on a considerable scale, notably in Canada, and by the spraying practices of many practical fruit-growers. It is the purpose of this paper to add to these accumulating proofs of Illingworth's thesis the corroborative results obtained from some field orchard experiments made in New York during the season of 1919. In this connection I wish to acknowledge the invaluable aid of Mr. E. A. Rundlett, assistant Farm Bureau agent of Columbia County.

The apple maggot is abundant and destructive in the Hudson River Valley; and in Columbia County, according to a rather extensive and careful survey by Rundlett, it constitutes one of the two or three major apple pests. It has been particularly injurious to the Maiden Blush, Alexander, Greening, Baldwin, Duchess, and Northern Spy in the orchards of Mr. James Van Alstyne and Mr. A. T. Ogden near Kinderhook, N. Y. In the orchards of Mr. Van Alstyne, for the past four years, the Alexanders have been so seriously infested that few have been fit for shipping. All of them during the season of 1918 were seconds and a large part of them dropped and were worthless. The Maiden Blush apples have also dropped badly and in 1918, especially, were nearly worthless. The Baldwins and Greenings have been badly infested with the maggot and many of them reduced to seconds while a goodly percentage have been rendered worthless for market purposes.

In the orchard of Mr. Ogden last year (1918) seventy odd barrels of Northern Spies were produced on his trees of which only three-fourths of a barrel were of first quality. The others were so badly infested that they were either put in as seconds or not marketed at all. The crop was considered a failure. Nearly all of his other varieties were infested, especially the Baldwins and Duchess.

During the last days of June the writer, in company with Mr. Rundlett, visited the orchards named and arranged for the application of the poison sprays. Mr. Van Alstyne applied the first spray, 6 pounds of arsenate of lead to 100 gallons of water, on July 3. The second application was made on July 17 and 18, practically two weeks

after the first. The following table gives the weather conditions as recorded by Mr. Rundlett in Columbia County during this interval.

July 1.	Warm and fair	July 10.	Cool, rainy
2.	Hot, fair	11.	Cool, fair
3.	Hot, fair	12.	Warm, fair
4.	Hot, fair	13.	Fair
5.	Hot, fair	14.	Warm, fair
6.	Warm, rain	15.	Cool, cloudy, very humid
7.	Warm, fair	16.	Rain in morning, clear afternoon
8.	Cool, fair	17.	Warm, fair
9.	Cool, fair	18.	Warm, fair

The orchards on Mr. Ogden's place were sprayed first for the maggot on June 30 and the second time on July 17. Powdered arsenate of lead 3 pounds to 100 gallons of water was used in these orchards and since the places are near together the weather conditions were similar. It should be stated in this connection that the spraying was done rather thoroughly, care being taken to cover all of the foliage of each tree from the lowest to the highest branches. Moreover special effort was made to spray every apple tree on the place so as to leave no breeding grounds. I visited and examined the orchards in company with Mr. Rundlett on September 11. The Alexanders and Maiden Blush on the farm of Mr. Van Alstyne had been harvested. He said that 75 per cent of the Alexanders were of quality A and that the crop, as a whole, was fine. The Blush apples dropped but little, were remarkably free from infestation, and, as he expressed it, "were fine."

The Baldwins and Greenings were still on the trees and were in fine condition—as handsome a crop as I have seen this year. Later, Mr. Van Alstyne tells me, some infection of scab developed on the Greenings. Only occasionally could we find an infested apple on the trees and there were very few drops. It is worthy of note that two trees, one a Spy, close to the house, and another variety, the name of which I do not recall, that stood on an inaccessible bank behind the poultry house, were not sprayed. I believe that every apple on the Spy tree was infested with maggots and a very large percentage of those on the inaccessible tree. These two trees will be cut and burned before spring and thus the breeding grounds destroyed.

Perhaps the crop of Spies in the orchard of Mr. Ogden afforded the most striking example of the results of the spraying. The trees bore a fine crop, probably more than last year and we did not find an infested apple. So far as color, smoothness, and freedom from injury were concerned the apples, as the foreman said, would nearly all go in quality A. Size, however, would prevent such a realization. When the Spies were picked, however, a slight infestation was found which is

described in the following words by Mr. Ogden, "To my great delight I find almost no maggot. A little in the Spies but *almost none*—last year I could not get two barrels of good Spies out of 75."

Last year the Baldwins and Duchess in these orchards were badly infested. This year these varieties were practically free from infestation. In answer to my question, "Did the two applications of poison that you made control the apple maggot satisfactorily?" Mr. Ogden replied in the following words: "Absolutely. I doubt if we could do a better job. I have nearly 2,000 barrels this year and a very high per cent of A grade. I am satisfied by following same method we can control."

The results in these two carefully sprayed orchards were obtained in face of the fact that the maggot was more or less abundant in the whole of the western border of Columbia County and caused general loss to nearly all of the growers as Rundlett determined by his careful survey.

Situated near Mr. Van Alstyne's place is a large dairy farm having a small orchard on it of mixed varieties. It appears that all of the varieties in this orchard have been badly infested with the maggot for some years and we were anxious to have it sprayed as a matter of protection. We were able to induce the dairy foreman to give this orchard two sprayings at about the same time as the other orchards were sprayed although I do not have the exact dates. This orchard was sprayed with lime-sulfur and arsenate of lead each time. So far as we could judge in talking with the foreman the spraying had not been done with any great care or thoroughness and with little interest in the matter. The owner was ill and unable to look after any outside matters and the foreman is a dairyman. The results were not satisfactory to the entomologist although the foreman was very enthusiastic because the apples were so much freer of the maggot than they had been in previous years. As a matter of fact, there was considerable infestation in nearly all of the varieties we examined and a goodly percentage of drops. Either the addition of the lime-sulfur or the careless spraying or a combination of both factors prevented the success obtained in the other orchards where the prime object was to destroy the maggot.

Caesar and Spencer[1] have obtained experimental evidence which indicates that the cherry-maggot flies are not destroyed as effectively by a mixture of lime-sulfur and arsenate of lead as they are by arsenate of lead alone in water or by a combination of arsenate of lead, molasses, and water.

The results of these coöperative field experiments, it seems to me, show that rather more thorough spraying than I formerly deemed im-

[1] Caesar, L., and Spencer, G. J., Cherry fruit-flies, Dept. Agr., Ont. Can., Bul. 227, pp. 22 and 28, 1915.

portant is necessary to the most successful control of this insect. In addition to this I am convinced that all of the apple trees liable to infestation in an orchard should be sprayed in order to prevent any migration of the flies from untreated varieties. In any clean-up attempt all old derelict trees about the farm buildings should be thoroughly sprayed or else cut down and destroyed.

WILD HAWTHORNS AS HOSTS OF APPLE, PEAR AND QUINCE PESTS

By Walter H. Wellhouse, *Ithaca, N. Y.*

The wild hawthorn trees have for many years been recognized by entomologists as the native hosts of a number of injurious native insects which now attack the apple, pear and quince, having adopted these hosts after they were introduced and cultivated in North America. Among the number may be mentioned the apple maggot, *Rhagoletis pomonella*, the dark apple red bug, *Heterocordylus malinus*, the quince curculio, *Conotrachelus cratægi*, the lesser apple worm, *Laspeyresia prunivora* and the woolly apple aphis, *Eriosoma lanigera.*

This migration to new hosts has been generally attributed to the close botanical relationship which exists between the hawthorns and the apple, pear and quince, all four being classed in the apple family. Another factor which tends to make these hosts interchangeable is their almost identical habitat. This allows insects which are restricted by differences in temperature, moisture, light or soil, as well as by botanical relationship, to accept apple in place of hawthorn. The native hawthorns grow wild in most of the apple and pear growing sections of the country. The planting of orchards in places where hawthorns were growing has already initiated a number of new fruit tree pests. With the continued extension of agriculture the uncultivated areas where hawthorns grow are still being reduced and their insect population must continue to seek substitute hosts.

The writer has a list of 374 species of insects which have been found to feed upon the hawthorns, and 210 of the species are found in the United States. Very few of these seem to be permanently injurious to the hawthorns and many of them do almost no injury, yet when they adopt as a host the apple, pear or quince which has been nursed and shielded from hardships so long that it has become tender and nonresistant, the injury may become much greater. For instance the puncture of the quince curculio in the side of a haw causes no great deformation of the fruit but its puncture in the side of a quince or pear will cause a marked depression and result in a knotty fruit.

Among the more important of the species which are now only Cratægus or hawthorn pests but which we may probably expect on our cultivated fruits later are the following:

The hawthorn blossom weevil, *Anthonomus nebulosus* Lec. Its life history and habits are identical with those of the apple blossom weevil of Europe which, according to Theobald, sometimes destroys 40 per cent of the apple crop in England. As yet our species attacks only Cratægus but its habit of attacking the fruit buds would make it a very dangerous pest if it should attack the apple.

The hawthorn fruit miner, *Blastodacna curvilineella* Chamb. The larvæ of this little Cosmopterygid are among the most common causes of "wormy" haws in Central New York and they probably are distributed at least over the eastern states. The larvæ have the habit of leaving the fruit in early autumn and burrowing into a dead twig or weed stem to spend the winter. They have undoubtedly been long overlooked because they are very active and work their way through the breeding cages to escape even through several layers of fine meshed cheese cloth.

A new leaf bug, *Lygus univittatus* Knight, resembling the false tarnished plant bug in appearance, has been found by the writer puncturing the fruits of Cratægus at Ithaca and Knight believes this will eventually become an apple pest. Its punctures do not deform the haws to any extent but may affect the apple differently.

A number of leaf-hoppers, the most numerous of which are *Empoa querci*, *Lamenia vulgaris*, *Erythroneura obliqua*, and *Idiocerus provancheri*, cause considerable damage to the Cratægus foliage.

The four-spotted hawthorn aphid, *Macrosiphum cratægi* Monell, remains all summer on hawthorn and has caused much damage to the trees even during warm dry weather. It is easily distinguished from our common hawthorn and apple aphids by the four conspicuous dark green spots arranged in a rectangle on the backs of the apterous females.

Argyresthia oreasella Clem. A little white and gold bud moth which in the larval stage bores into the terminal buds causing them to wilt and die in May. The blackened terminals are occasionally very numerous on hawthorns about Ithaca.

Over 100 species of insects which feed on apple also feed on hawthorns. Among them are the following common apple pests:

False tarnished plant bug, *Lygus communis*
Apple aphids (*Aphis avenæ*, *A. pomi*, *A. sorbi*, *Eriosoma lanigera*)
Scale insects (*Aspidiotus perniciosus*, *Chionaspis furfura*, *Lepidosaphes ulmi*, *Lecanium corni*, etc.)
Flea beetles (*Haltica foliacea* Lec., *Crepidodera helxines* Linn., etc.)

Apple curculio, *Anthonomus quadrigibbus*
Plum curculio, *Conotrachelus nenuphar*
Apple weevil, *Pseudanthonomus cratægi*
Hickory tussock moth, *Halisidota caryæ*
White marked tussock moth, *Hemerocampa leucostigma*
Antique tussock moth, *Notolophus antiqua*
Yellow-necked apple caterpillar, *Datana ministra*
Red-humped apple caterpillar, *Schizura concinna*
Tent-caterpillars, *Malacosoma americana, M. disstria*
Fall webworm, *Hyphantria cunea*
Leopard moth, *Zeuzera pyrina*
Canker-worms, *Alsophila pometaria, Paleacrita vernata*
Bud moths, *Tmetocera ocellana, Recurvaria nanella*
Leaf rollers, *Archips argyrospila, A. rosaceana, Ancylis nubeculana, Eulia quadrifasciana*
Lesser apple worm, *Laspeyresia prunivora*
Case bearers, *Coleophora fletcherella, C. malivorella*
Leaf miners, *Tischeria malifoliella, Ornix geminatella*
Leaf crumpler, *Mineola indigenella*
Apple maggot, *Rhagoletis pomonella*

The popular belief that the round-headed apple-tree borer, *Saperda candida,* and the codling moth, *Cydia pomonella,* are common feeders on Cratægus has not been borne out by the writer's observations. In a number of natural thickets where hawthorns and seedling apple grow together the round-headed borers have been watched for two years. The adults were quite commonly found resting on the foliage of both hawthorn and apple in June and July but the larvæ could be found only in the apple. The apple was so heavily infested that very few trunks remained standing and many young sprouts from the roots had grown up in their places. The larvæ were found girdling these sprouts and were also infesting a well kept orchard across the railroad track. The hawthorns showed no sign of having been touched by the borers. At least two of our common species of hawthorns, *Cratægus punctata* and *C. pruinosa* were present in these thickets.

The codling moth has not been found among the insects reared from the haws during the past two seasons and only one record has been found of its ever being reared from hawthorn. That is in the notes of the late Professor Slingerland. He states that in September 1890 "I gathered a lot of haws and placed them in cages to breed the codling moth. Examined several (25 perhaps) of the haws and never failed to find at least one larva in each. May 13 one adult emerged. Several other smaller moths were found in the cages also. May 19 one adult emerged and is pinned." The smaller moths were probably the lesser apple worm, *Laspeyresia prunivora,* since this species has been reared in abundance from the haws. The larvæ of *L. prunivora* have undoubtedly been mistaken for those of the codling moth in

many cases and since their resemblance is very close it is not surprising that the codling moth was believed to breed quite commonly in haws.

In view of the fact that the wild hawthorns are hosts of many of our present apple, pear and quince pests and also of many potential insect pests, not to mention the cankers, blights and rusts which they may harbor, should we not remove them from the vicinity of our orchards or at least give them insecticidal treatment? The cumulative benefit which would be gained from spraying an orchard several years in succession may be lost if the surrounding country continually furnishes a new supply of pests.

SOME STUDIES ON THE EFFECT OF ARSENICAL AND OTHER INSECTICIDES ON THE LARVÆ OF THE ORIENTAL PEACH MOTH

By Alvah Peterson, *Assistant Entomologist, New Jersey Agricultural Experiment Station*

Introduction

The oriental peach moth, *Laspeyresia molesta* Busck is found in several localities in New Jersey. It is particularly abundant in orchards about Red Bank and New Brunswick. The author has given this pest considerable attention for two seasons, 1918 and 1919.

During these seasons it has been noted that there have been at least three full broods and a partial fourth. The first larval injury to the twigs in 1919 was seen the first week in June at Mr. J. C. Hendrickson's three year old peach orchard (Hale variety) near Middletown, N. J., at that time no tree possessed over ten injured twigs. In 1918 this orchard was severely infested. Some of the trees had over 90 per cent of the twigs injured during the month of July. During 1919 the infestation in this orchard was approximately 50 per cent less than in 1918. The last freshly injured twig observed in 1919 was found on August 30 in the orchard at the college farm.

Twig injury to peach trees is most severe during the first three years after the trees are set out in the orchard. It has been repeatedly observed that in old orchards (five years or more) twig injury is not serious. Several old orchards have been examined which are adjacent to heavily infested young orchards and little or no twig injury could be found. It is apparent that the larvæ prefer young, tender, vigorously growing shoots.

The first fruit injury in 1919 was seen the last week in June while the last fruit infestation was observed on September 10 at New Brunswick. So far as known, no fresh larval injury of any description has been seen

after this date in New Jersey. Fruit injury to peaches has seldom exceeded 10 per cent of the crop in any orchard in this state. In most orchards it was much less than 10 per cent. This pest has also been found attacking the fruit of apple and quince trees in New Jersey. Entomologists in other states have recorded injury to cherry, plum and apricot trees and also to ornamental fruit stock.

The larva, when it hatches from the egg is very small, somewhere between 1–2 mm. in length. When it is full grown it measures 12–13 mm. in length. The larva usually enters a growing peach twig at its distal end; however, it may make its way into the shoot near the base of a leaf petiole or the point of entrance may be the petiole itself. Before it enters it usually spins a loose silken cocoon about its body. The silken threads close the open spaces between the leaves at the point where the larva enters. Larvæ that are half grown or larger seem to be more inclined toward spinning a loose cocoon before entering than very small larvæ. Usually before the silken cocoon is completed the larva proceeds to bite out pieces of green tissue from the stem or small leaves and places these particles on the thin web about its body. The green particles soon dry and turn brown, thus making a collection of brown frass at the point of entrance.

So far as known, the larva does not consume any of the outer green tissue of the twig at the point where it enters. It, apparently, waits until it is within the stem before it partakes of food. The above fact seems to be true of all larvæ, particularly those that are half grown or larger. Other investigators have also recorded the above observations in respect to the feeding habit of the larva. Since the larva fails to consume the outer green tissue as it enters a shoot this probably accounts for our failure to obtain a satisfactory control in orchard experiments with arsenical sprays in 1918.

One larva may enter several growing shoots, three or more, before it obtains sufficient food to complete its larval development. This fact, in part, accounts for the large number of injured twigs one may observe on a heavily infested tree and yet find comparatively few larvæ.

Larvæ also enter the fruit of peach trees. Many of them go into the fruit near the stem end, but they also enter the sides of the peaches. The larvæ usually deposit a mass of green tissue at the point of entrance on the fruit. Here again the larvæ, apparently, do not consume their first mouthfuls of peach tissue.

Experiments

During 1918 a number of severely infested trees were carefully sprayed with arsenical mixtures of varying strengths. In no case were we able to get over a 50 per cent reduction in the number of

infested twigs and on some trees the infestation was not appreciably reduced. This season instead of carrying on extensive orchard experiments most of the tests were conducted at the laboratory and on small individual trees. Under these conditions we could carefully watch the behavior of the larvæ.

The following tables show the results of placing individual (usually no more than one on a twig or fruit) larvæ on treated, freshly cut, peach twigs and treated, freshly picked green fruit. When liquid sprays were used, the material was applied with a small hand atomizer in such a way as to thoroughly coat the twig or fruit. Casein-lime composed of 50 per cent casein (lactic) and 50 per cent hydrated lime was used as a spreader for some of the liquid sprays. The larvæ were placed on the liquid treated twigs and fruit as soon as they were dry. The dusts were placed in a small hand dusting bag which was made of two thicknesses of fine mesh cheese-cloth and then shaken onto the twigs or fruit.

In Tables I and II the larvæ used in the experiments varied in length from 5–9 mm. while in Table III the exact size of each larva was known. In Table III the larvæ have been grouped into three sizes, 2–4, 5–6, and 7–9 mm. Larvæ larger than 9 mm. were not used because the majority of them (upon removal from a twig) show a strong tendency to seek a place to build a cocoon and pupate rather than reënter a new shoot or fruit. Whenever material was needed for experiments, newly infested twigs were collected from nearby orchards and the larvæ were removed. They were immediately placed on newly treated, freshly cut twigs or fruit. The cut ends of the twigs were placed in water to keep them fresh while the individual peaches were each placed under a separate glass dish. Observations on most every test were made 12, 24 and 48 hours after the start of each experiment. The observations recorded in the tables were taken 48 hours after the experiment was started. This gave sufficient time for the poison to act on the larvæ provided they consumed the same. In order to be sure of this point observations were always made at the end of three to five days with each substance tested and in no case was there any change in the results compared with the 48 hour record. In most instances the larvæ had entered or started to enter the twigs or fruit 12 hours after they were placed on the same. If they did not enter in this period they usually refused to do so. Many of the larvæ recorded as lost or in the column showing no injury or no larva seen, were present, alive and active at the 24 hour period, but for some reason disappeared by the 48 hour period. They may have become dislodged while wandering over the smooth surface of the twigs or it is probable that some of them were poisoned.

The results of the liquid spraying experiments with the twigs (Table I) show that one or more larvæ were able to penetrate any of the coatings put on the new peach shoots and safely reach the center of the treated twig. None of the arsenical sprays employed stopped the larvæ from entering. In a few instances some of the younger larvæ seemed to be repelled by the poisoned material.

The results of the dusting experiments (Table II) show a very small percentage of kill. With the exception of Paris green, two or more larvæ in each set of tests entered the thoroughly dusted twigs. Paris green and magnesium arsenate showed the greatest percentage of kill, but these substances by themselves will injure peach foliage. Hellebore, pyrethrum, tobacco lime and lime-sulfur dusts were also tried. None of these were effective except pyrethrum. This substance seemed to have a repellent effect. The larvæ were not killed by the pyrethrum, but most of them refused to enter the twigs coated with this dust.

Table III shows the response of larvæ of known size to lead arsenate mixtures (lime and sulfur) when used in liquid and dust forms. The poison was thoroughly applied to immature peaches. A very small percentage of the 2–4 mm. and 5–6 mm. larvæ, but none of the 7–9 mm. larvæ, were killed by the lead arsenate when it was applied in liquid form at the rate of 2 to 4 pounds to 50 gallons of water with the addition of casein-lime, 2 pounds to 50 gallons, acting as a spreader.

All larvæ smaller than 4 mm. were killed when placed on fruit coated with a fine dust of lead arsenate, 1 part and hydrated lime, 5 parts or lead arsenate, 1 part and finely ground sulfur, 1 part. Of the two mixtures the lead arsenate and sulfur mixture was more effective with the larger larvæ for it killed over 80 per cent of the 5–6 mm. larvæ and 30 per cent of the 7–9 mm. larvæ while the lead arsenate and lime dust only killed 60 per cent of the 5–6 mm. larvæ and 2 per cent of the 7–9 mm. larvæ. Finely divided hydrated lime by itself killed 40 per cent of the 2–4 mm. larvæ and over 35 per cent of the 5–6 mm. larvæ, but none of the 7–9 mm. larvæ. This substance does not act as a stomach poison, but the lime seems to make it difficult for the small larvæ to crawl over a coated surface. The fine dust-like particles of lime catch on the ventral aspect of the body and also cling to the fine setæ scattered over the various segments. This probably causes the thin skin of the larva to become very dry. Many of the larvæ on the dusted fruit seemed to gradually decrease in size and shrivel before they died.

The coating of dust on the fruit in the above experiments was probably somewhat heavier than what might be found on the average fruit when dusted under orchard conditions. The results of the above dust-

TABLE I.—THE EFFECT OF ARSENICAL AND OTHER LIQUID SPRAYS ON LARVÆ OF VARIOUS SIZES (5–9 MM.) WHEN THE LARVÆ ARE PLACED ON TENDER GROWING PEACH TREE TWIGS WHICH ARE THOROUGHLY COATED WITH THE SPRAY MIXTURE

Experiment number	Liquid sprays	Larvæ alive inside of twig	Larval injury but no larvæ seen	Larvæ dead	Larvæ alive outside of twig	No larvæ or injury seen	Total larvæ in trials
1	Lead arsenate, 2 lbs.–50 gals	6	1	0	2	4	13
2	Lead arsenate, 2 lbs.–50 gals., plus casein-lime, 2 lbs.–50 gals	8	0	0	1	3	12
3	Lead arsenate, 4 lbs.–50 gals	6	0	0	0	0	6
4	Lead arsenate, 4 lbs.–50 gals., plus casein-lime, 2 lbs.–50 gals	4	0	0	1	2	7
5	Calcium arsenate, 2 lbs.–50 gals	12	1	0	0	0	13
6	Calcium arsenate, 2 lbs.–50 gals., plus casein-lime, 2 lbs.–50 gals	3	1	0	0	1	5
7	Magnesium arsenate, 2 lbs.–50 gals	8	0	0	1	3	12
8	Magnesium arsenate, 2 lbs.–50 gals., plus casein-lime, 2 lbs. 50 gals	5	1	0	0	0	6
9	Zinc arsenite, 2 lbs.–50 gals	3	1	0	1	0	5
10	Zinc arsenite, 2 lbs.–50 gals., plus casein-lime, 2 lbs.–50 gals	5	0	0	0	3	8
11	Paris green, 2 lbs.–50 gals	6	0	0	0	2	8
12	Paris green, 2 lbs.–50 gals., plus casein-lime, 2 lbs.–50 gals.	3	2	0	0	1	6
13	Hellebore, 1 gm.–100 cc., plus f. o. soap, 1 gm.–100 cc	3	3	0	0	1	7
14	Nicotine, 1 cc.–500 cc., plus f. o. soap, 1 gm.–200 cc	2	0	0	0	5	7
15	Nicotine resinate, 1 cc.–500 cc	8	0	0	0	6	14
16	Crude carbolic acid, 1 cc.–99 cc. plus f. o. soap, 1 gm.–200 cc	1	0	0	2	4	7
17	Lime-sulfur, 1 cc.–40 cc	3	0	0	0	0	3
18	"Scalecide," 1–40	5	0	0	0	0	5
19	"Sulfolium," 1–50	3	0	0	1	4	8
20	Check	9	0	0	0	1	10

ing experiments with fruit show that the small larvæ may be killed by a combination of lead arsenate and lime or lead arsenate and sulfur, but many of the larger larvæ will not be killed.

A series of experiments were conducted with fruit in place of tender peach twigs. The insecticides used were similar to those shown in Tables I and II. The results obtained (not shown in table form) were in many ways similar to those shown in Tables I to III. The various arsenicals applied as dusts to the fruit were superior to liquid sprays in killing the larvæ, yet in no case was there a complete control. A few of the larvæ were killed when the arsenicals were used in liquid

Table II.—The Effect of Arsenical and Other Dusts on Larvæ of Various Sizes (5–9 mm.) When the Larvæ Are Placed on Tender Growing Peach Tree Twigs which Are Thoroughly Dusted with the Mixtures

Experiment number	Dusts	Larvæ alive inside of twig	Larval injury but no larvæ seen	Larvæ dead	Larvæ alive outside of twig	No larvæ or injury seen	Total larvæ in trials
21	Lead arsenate	6	0	0	1	2	9
22	Lead arsenate, 1 pt.–lime 5 pts.	11	3	0	0	0	14
23	Lead arsenate, 1 pt.–sulfur 1 pt.	10	2	1	1	3	17
24	Calcium arsenate	6	0	2	0	2	10
25	Calcium arsenate, 1 pt.–lime 5 pts.	10	0	0	0	5	15
26	Magnesium arsenate	3	0	1	4	3	11
27	Magnesium arsenate, 1 pt.–lime 5 pts.	4	1	1	2	10	18
28	Zinc arsenite, 1 pt.–lime 5 pts	8	2	0	1	4	15
29	Paris green	0	1	3	1	1	6
30	Paris green, 1 pt.–lime 5 pts.	2	2	1	0	3	8
31	Hellebore	6	2	0	1	5	14
32	Hellebore, 1 pt.–lime 5 pts.	5	0	0	1	0	6
33	Pyrethrum	4	0	0	5	10	19
34	Pyrethrum, 1 pt.–lime 5 pts.	4	0	0	1	4	9
35	Tobacco	10	0	0	0	4	14
36	Tobacco, 1 pt.–lime 5 pts.	2	1	0	0	8	11
37	Lime (hydrated)	6	0	0	0	0	6
38	Lime-sulfur	4	1	0	0	1	6
39	Check	12	0	0	1	1	14

form at the rate of 4 pounds to 50 gallons of water, but when the arsenicals were used at the rate of 2 pounds to 50 gallons of water, except Paris green, none of the larvæ were killed. When the arsenicals were applied as dusts the calcium and magnesium arsenates, alone or in combination with hydrated lime, killed approximately the same percentage of larvæ as the lead arsenate (alone or in combination with lime). Dusts of hellebore, pyrethrum and tobacco did not keep the larvæ out of thoroughly coated fruit. Pyrethrum seemed to have a slight repellent effect.

Comparing the various series of experiments where twigs were used with those where peaches were used, the best killing results were obtained in the fruit series. This may be due to the fact that it is exceedingly difficult to get a thorough coating of poison (liquid or dust) on and into all parts of a growing peach twig. The surface of the leaves and stem on a peach twig is smooth and this makes it difficult for the

TABLE III.—THE EFFECT OF LEAD ARSENATE (LIQUID AND DUST MIXTURES) ON LARVÆ OF KNOWN SIZE. THE SPRAY AND DUST MIXTURES THOROUGHLY COATING THE ENTIRE SURFACE OF IMMATURE PEACHES

Experiment number	Liquid sprays and dusts	2–4 mm. larvæ		5–6 mm. larvæ		7–9 mm larvæ		Total larvæ	
		Entered	Dead	Entered	Dead	Entered	Dead	Entered	Dead
40	Lead arsenate, 2 lbs.–50 gals., plus casein-lime, 2 lbs.–50 gals.	8	5	48	1	29	0	85	6
41	Lead arsenate, 4 lbs –50 gals plus casein-lime, 2 lbs.–50 gals.	8	3	39	3	27	0	74	6
42	Lead arsenate, 1 pt.–lime 5 pts (dust)	0	8	17	28	44	1	61	37
43	Lead arsenate, 1 pt.-sulfur 1 pt. (dust)	0	15	8	38	42	18	50	71
44	Hydrated lime (dust)	6	4	22	14	39	0	67	18
45	Check	13	0	29	0	32	0	74	0

material to stick. Dusts adhere better than liquid sprays due to the fact that a growing peach shoot has a somewhat sticky surface. The surface of a peach is pubescent, consequently liquid sprays and dusts readily cling to its surface. Again it is probable that a larva entering a thoroughly dusted fruit is more apt to consume some of the poison than a larva entering a twig.

In addition to the above experiments with peach twigs and fruit a number of immature apples were dusted and sprayed with various lead arsenate mixtures (as given in Table III). In no case did the poison prevent the larvæ from entering the fruit. The larvæ used in these experiments were at least half grown and larger.

Dr. P. Garman suggested the spraying of infested twigs with arsenical poisons with the hope of killing the worm as it ate its way out of the twig. The larva usually eats its way out of the twig near the terminal end of its interior channel. This may be several inches from the point of entrance. Fifty twigs were collected which seemed to possess living larvæ. Twenty-five of these were thoroughly sprayed with lead arsenate at the rate of 4 pounds to 50 gallons of water with the addition of casein-lime, 2 pounds to 50 gallons of spray and the other twenty-five twigs served as a check. Ten days after the experiments were started the cloth cages in which the experiments were enclosed were examined. The check showed sixteen larvæ alive on the walls of the cage or pupating in cocoons and one dead, while the sprayed lot showed fourteen larvæ alive on the walls of the cage or pupating and two dead. This experiment was repeated and similar results were

obtained. These two tests show that a coating of lead arsenate on an infested twig has little or no effect on the larva when it eats its way out.

The author hoped to make a careful study of the response of newly hatched larvæ to the various sprays which have been used in the above experiments. Unfortunately he was unable to secure a sufficient quantity of fertilized eggs to make this investigation. Caged adults and field collections did not give a sufficient supply. Newly hatched larvæ will probably respond to the above insecticides in the same way as the 2–4 mm. larvæ. It is also probable that they are more susceptible. If such is the case thorough dusting of fruit and tender growing twigs with some arsenical insecticide should kill all of the newly hatched larvæ as they enter a thoroughly dusted fruit and possibly all of the newly hatched larvæ as they enter a thoroughly dusted twig.

DIPPING TOBACCO PLANTS AT TRANSPLANTING TIME FOR THE CONTROL OF THE TOBACCO FLEA BEETLE (EPITRIX PARVULA FABR.)

By Z. P. Metcalf, *North Carolina State College and Experiment Station*

One of the critical times in the life of a tobacco plant is naturally just after it has been transplanted and added to this natural handicap is an artificial handicap caused by the presence of swarms of tobacco flea beetles which come from the tobacco beds and other feeding places and do great damage to the plants at this season of the year. This injury results in a weakening of the plant and may cause its death. In the latter case the loss is total unless a new plant is used to replace the dead plant. The loss due to these attacks is normally very great every season and may be divided into two items: a direct loss due to the additional labor involved in replanting and an indirect loss due to the slow growth of the injured and replanted plants, which makes them mature later in the fall. Such plants as these are always badly damaged by flea beetles just before harvest time.

With these points in mind we have been working for the past three years to devise a method for tiding the tobacco plants over this critical period. Reduced to its simplest terms our directions at present are to prepare a solution of arsenate of lead into which the plants are dipped. This mixture should be carefully prepared and kept thoroughly agitated by stirring frequently with a paddle. Then as the plants are pulled from the bed they should be laid out straight in small bundles. Each bundle should be picked up separately and the leaves only dipped into the arsenate of lead solution. The plants should be separated as much as possible while they are in the solution, so that every leaf will receive a coating of the poison. As the plants are withdrawn they should

be shaken slightly to remove the excess poison. Care must be taken not to shake them too violently or too much of the poison will be removed. After a few bundles are dipped look at the first bundles and notice whether the leaves are completely and uniformly covered with a dry white powder. If large drops of water have collected here and there on the leaf it means that the plants should be shaken a little bit more as they are removed from the poison. Tobacco plants can be set practically as rapidly in this way as by the old method, for the additional labor involved is very slight indeed.

The other factor involved was to determine just what strength of arsenate of lead solution to use. Apparently the tobacco plant, when properly hardened off before transplanting, will stand almost any amount of arsenate of lead. Plants have been dipped in solutions of arsenate of lead as strong as 20 pounds of dry powder to 50 gallon of water without any injurious effects appreciable. However, solutions as strong as this are not necessary and this past year we carried on a series of experiments to determine whether 1 pound or 2 pounds of powdered arsenate of lead to 10 gallons of water would give the better results. Briefly the results of an inspection made two weeks after the plants had been transplanted may be summarized as follows:

TREATED WITH ARSENATE OF LEAD ONE POUND TO TEN GALLONS OF WATER

	Per Cent
Plants not injured	51 3
Plants slightly injured	35 4
Plants badly injured	5 6
Plants replanted	2.6
Plants badly sun scalded	5.1

TREATED WITH ARSENATE OF LEAD TWO POUNDS TO TEN GALLONS OF WATER

	Per Cent
Plants not injured	63 0
Plants slightly injured	22.6
Plants badly injured	1.0
Plants replanted	3.6
Plants badly sun scalded	9.8

CHECK

Plants not injured	0.0
Plants slightly injured	7.1
Plants badly injured	91.1
Plants replanted	1.1
Plants sun scalded	.7

Analyzing the above results we find a total effectiveness for the one pound of lead of 78 per cent, counting both the uninjured and slightly injured, as effectively treated and assuming on the basis of the check that only 90 per cent of the plants would be badly injured in this time

and a total effectiveness of 77 per cent for the two pounds of arsenate of lead. On the other hand nearly 6 per cent of the plants treated with one pound of lead were badly damaged as against 1 per cent for the plants treated with two pounds. The number of replants made up to this inspection is practically identical. Later inspections, however, show a decided advantage for the treated plots, only 2 per cent being replanted whereas the check plot showed 17 per cent replants. The term sun scalded is used to express an unknown factor which caused a burning on the tips of the leaves and which might be attributed to the poison used, especially in light of the fact that this condition was nearly twice as bad in the plants treated with two pounds as it was in the plants treated with one pound, but for the following facts, some of the plants in the check plot were also badly scalded and an adjacent field set on the following day which received no treatment was sun scalded worse than the treated plots.

In view of these experiments our recommendation to the farmers is that the plants should be dipped in arsenate of lead, 1 pound powder or 2 pounds paste, to 10 gallons of water.

THE LIFE HISTORY OF THE POTATO LEAFHOPPER (EMPOASCA MALI LE BARON)

By F. A Fenton and Albert Hartzell, *Iowa State College, Ames, Iowa*

The potato fields of Iowa and the surrounding states have suffered severely from burning for several years until this condition has become a seriously limiting factor in the production of this crop. Dr. Ball[1] has previously demonstrated that the potato leafhopper was responsible for this condition and has aptly termed the disease "hopperburn." This discovery made the control of the leafhopper the most important problem in connection with potato production.

In order to control this insect it was first necessary to know its life history on potato, of which little was known, owing principally to the fact that these hoppers were so minute, active, and difficult to keep alive under artificial conditions. The problem of its life cycle was primarily one of the proper technique. Much time was therefore spent in perfecting methods and devices for keeping these insects under observation. The methods employed at the outset were only partly successful but later were improved with satisfactory results on all important phases of the study.

Climatic Factors

The season of 1919 was abnormal in the excess of early precipitation followed by exceedingly high temperatures. There were two long

[1] Science, N. S., Vol. 48, Aug. 1918, p. 194. Jour. of Econ. Ent., Vol. 12, No. 2, 1919, pp. 149–154.

periods of drought, the first extending from early June to early August, and the second from the middle of August to the middle of September. A maximum high temperature average was reached by the middle of June, and lasted until early September, the hottest period coming in late July.

Experimental Methods

Data was obtained largely from cage experiments and checked up by field observations. The cages were kept in a greenhouse which was shaded and well-ventilated and in the fields under as normal conditions as possible. Records on the first or summer generation were based on observations made on a plot of early Ohio potatoes at Ames,

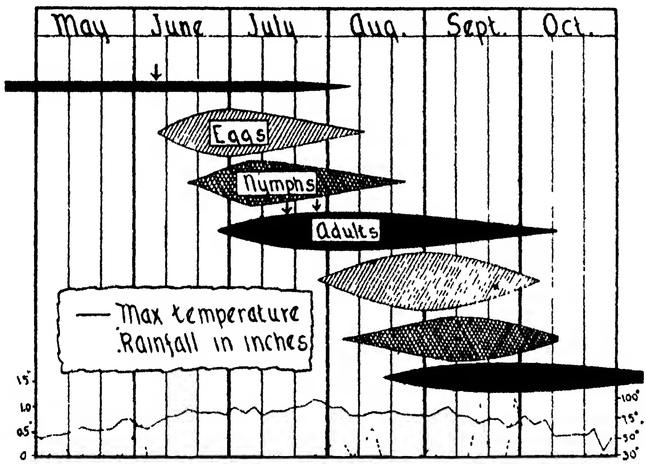


Fig. 13. Life history of *Empoasca mali* in potato

Iowa, while the experiments on the second generation were conducted on late varieties planted at Ames, and also on late potato fields in Mitchell County, Iowa.

Summary of Seasonal History

The potato leafhopper overwintered in the adult stage. These adults became active as early as April and were found on various weeds until June. They then deserted the weeds and migrated to early-planted potatoes as shown by the arrow on the life history chart. The females immediately began laying eggs on these vines, and continued to do so until late July, when most of them died. The first nymphs or young appeared on the vines by the middle of June, and became especially abundant late in this month and early in July, at which time they caused the potato vines to burn badly. By August,

these first brood nymphs had largely disappeared, having matured into the summer generation of adult hoppers. These began appearing on the potato vines early in July and by the middle of this month were very numerous. They then migrated to the late potato fields which up to this time had been practically free from infestation. On them the females laid eggs which hatched into the second brood nymphs in late August and early September. These nymphs became especially abundant during the latter month producing the hopperburn on the late potato vines. At the time of frost all immature stages and summer brood adults were killed. Second generation adults matured from late August on, but did not lay eggs and produce a third brood. They remained on the vines until frost, when they flew to various weeds and other hardy plants that had not been touched by the cold. Here they stayed until these vines in turn were frosted, when they entered hibernation.

Spring Flight

Adults were found in small numbers feeding on grasses during April and early May, but they did not appear in any considerable numbers until late in this month, when they were very numerous on weeds and grasses. They were especially abundant on the common yellow dock, *Rumex crispus* L., which they preferred to several other kinds of weeds and young apple stock growing near by. Potted potato plants were placed among these weeds but were not touched by the hoppers. Similar conditions were observed everywhere. In no cases were they found on either apple, beans, or potatoes, in spite of the fact that they were present in numbers on other plants at this time.

On the morning of June 6 they suddenly left the weeds and migrated in large numbers to the potato plants. This phenomenon was observed generally and by several different persons. At this time there had been a drop of several degrees in temperature and a light shower. Just previous to this, there had been a period of rather high temperature followed by a rain, during which the mercury had dropped. This sudden and complete migration, coming at such a definite time, was evidently closely correlated with such climatic factors as temperature and humidity, as well as with sexual maturity, for females dissected at this time contained the first ripe eggs. At the time of this flight late planted potatoes were either not up, or just appearing above the soil, and thus were not infested by the hoppers. They remained free from these insects until the late July flight of the summer generation hoppers, thus proving that there was but one flight of the overwintered adults, and that once they had settled on the early potato fields there was no further dispersal.

Summer Flight

A general summer migration from early to late potatoes was observed in July. This took place over a considerable period of time, depending partly on the condition of the potato vines. In fields that had burned badly there was an early flight to either late potatoes or to fields in which many vines were still green. Otherwise this summer flight did not take place until late in July. That this was primarily not a forced migration because of lack of food plants was shown by the fact that it occurred in fields where there were still many green plants. Several fields were noted where, because of an especially severe infestation, the flight had been early, thus giving the vines a chance to send up vigorous sprouts. These were infested by adults from other fields that had burned late. However, in due time, no matter whether the vines were still green, the migration or mating flight was begun. It was evidenced at first by the swarming of the males at electric lights in the evening. In our experimental plots a row of Green Mountain potatoes, which had been practically free from infestation because the plants were not up at the time of the spring flight, received the first exodus from the surrounding early planted fields. This visitation was short, lasting only three or four days, but it was long enough to cause the vines to burn quite badly. Almost in a night, however, the hoppers disappeared from these vines and began their summer dispersal flight to late potato fields, leaving only a few scattered immature individuals. A few days later adult hoppers again appeared on these plants coming in from the surrounding fields.

This summer migration differed from the earlier spring flight principally in that it occurred over a longer period of time. This apparent difference may be explained by the fact that the earlier summer flights were due to lack of food and that the real migration and sexual flight took place as suddenly as it did in the spring. The highest temperatures of the season were recorded at this date but there was no rainfall.

How Long Do the Overwintered Adults Live?

Shortly after their appearance on the potato vines, eleven pairs of adult hoppers were placed in small cages for longevity records, while about fifty were collected and placed in a large wire cage as a check. The first female of the eleven pairs was observed dead July 9, most of them dying between July 21 and 23, while one lived until August 4. Similar records were obtained from the large cage, and July 26 all the hoppers in this were dead.

Further evidence that these females did not live much longer than late July was obtained by caging adults collected in the field at this

time on potato plants for oviposition records. But few nymphs hatched in these cages, showing that the overwintered females used had largely stopped laying eggs. This was also true in all the early potato fields observed, since most of the nymphs noticed on the plants were in the late instars and very few were hatching.

When the hoppers first migrated to the potato fields hundreds were examined for the proportion of sexes, which was found to be about even. By the middle of June there was a decided preponderance of females although there were still many males. June 30 it was very difficult to find a male in the field, and after a long search five were collected and placed in cages with females. Four of them died within a week, and one lived until July 8.

How Long Do the First Brood Adults Live?

Females of the first or summer generation were appearing in greatest abundance about July 10. Those maturing in cages at that period, owing to artificial conditions, began to die within a short time, while the longest records were twenty-four to twenty-five days. A month later most of this brood had become adult. Some of these later matured ones were caged and kept as long as they lived. They began to die as in the case of the earlier ones, but the more vigorous lived from twenty-five to thirty days and one survived until October 17, a period of sixty-one days.

Males lived on an average of ten days under cage conditions with a record of twenty-six days. In the majority of instances it was observed that the males died long before the females and shortly after copulation. Thus it would seem that the twenty-six day record was unusual.

How Long Do the Second Brood Adults Live?

Two series of cages were started in August and September to determine the length of life of the second generation adults. In the first series, one hundred pairs were kept in small cages and examined daily. Of this series twenty-two females and five males were alive October 17, or approximately 25 per cent. The higher percentage of mortality in the males was due to their greater activity. The second series consisted of five large cages each containing one hundred adults that had been collected in the field. The majority were alive November 8, when last examined, showing that under more natural conditions second brood adults lived throughout the fall and were alive at the start of winter.

Thus the second generation adults appeared in the fields in August and September and lived throughout the winter, becoming active again in the spring, many living until early August, a period of from

eleven to twelve months. On the other hand the first or summer generation in small cages lived from fifteen to sixty days, while in large field cages they averaged forty-five to sixty days. Under field conditions, probably two months was the average length of life as indicated by the fact that there was a definite maximum period of hatching of young which extended for approximately forty-five days.

Oviposition

Owing to the minute size of the egg and its concealment in the plant tissues it was impossible to make egg counts. In order to get daily records, females were placed with potato leaves for twenty-four hours and then these leaves were removed, labeled, and placed with their stems in water. From the number of nymphs that issued an estimate of the number of fertile eggs was obtained. Difficulty was experienced in keeping the potato leaves fresh long enough for the eggs to hatch, and so the records are incomplete in this respect. Two series of overwintered females were caged to obtain egg records. In June the females were caged before they had begun oviposition, while those caged July 1 had already been laying since June 6.

Table I Average Number of Fertile Eggs Laid per Day by Females

Number eggs laid per day	1	2	3	4	5
Number of records	72	21	5	4	2

The above table summarizes the results. In the majority of cases under cage conditions but one egg a day was laid, although frequently this was increased to two. Occasionally three, four, or even five were deposited and on some days none. Females dissected showed a maximum of four eggs matured at one time.

In general, oviposition of the overwintered females did not begin until after the spring flight. A few nymphs were found hatching on sweet clover in June for a short time, showing that some females had oviposited before migrating to potato. Females dissected directly after their appearance on potatoes contained mature eggs, while those examined previous to this date did not. Our earliest record for egg deposition under cage conditions was June 6, while few were laid after July 26. Thus with the overwintered females the oviposition period extended from June 6 to July 26, a period of fifty days.

Attempts were made to secure oviposition on early potatoes by females of the first generation in late July. The cages used were large glass globes placed over plants that had been cut down and allowed to sprout again. These plants were all vigorous and growing at that time. Practically no eggs were obtained, showing that these females were not ovipositing.

The first cage record of eggs of the summer generation adults was on July 11. Under field conditions hatching had become general July 23, showing that the above date was probably correct. Field counts also showed that the period of greatest egg deposition extended between August 6 and 24. A few nymphs were still hatching from the vines as late as October 3, so it is probable that oviposition of the summer generation extended throughout September, since these nymphs could not have been from second brood adults, as shown later. The average number laid a day was practically the same as with the overwintered generation, one fertile egg a day being the general rule under cage conditions.

Attempts to Rear a Third Generation

Attempts were made to get second generation females to oviposit but without success. All adults in this experiment were obtained by rearing nymphs that were known to belong to the fall generation. Owing to the nature of the cages used the mortality was high in this experiment. Second brood females, however, also failed to lay eggs in the large lantern globe cages used as checks. In these cages a much larger percentage of hoppers lived and were alive when last examined, November 8. This generation thus passes the winter without becoming sexually mature. They appear again, as stated, late in May and feed promiscuously for a week or so before the spring flight and oviposition take place.

Incubation Period

Under field conditions the incubation period extended from ten to fifteen days, with an average of fourteen. In the insectary, where the temperature averaged nine degrees higher than outside, the egg stage lasted from four to ten days for the first generation and four to twelve days for the second. An average of about seven days was noted for both broods under these conditions.

Table II. Incubation Period in the Field

Eggs laid	Average date hatched	Average incubation period	Average incubation for broods
June 3	June 17	14 days	
July 12	July 23	11 "	
July 14	July 26	12 "	first, 13 days
Aug. 2	Aug. 12	10 "	
Aug. 15	Aug. 27	12 "	
Aug. 29	Sept. 8	10 "	second, 11 days

TABLE III. INCUBATION PERIOD IN THE INSECTARY

Brood	Number of records	Minimum	Maximum	Average
1	109	4 days	10 days	7½ days
2	31	4 days	12 days	7 days

The greatest number of nymphs hatched during the morning, before the heat of the day. Certain conditions of temperature and humidity greatly influenced this, for hatching occurred at the same time throughout the whole field. During July this period generally came between 8.30 and 9.30 a. m., but later in September, not until after 10.

During the height of the egg-laying period, great numbers of nymphs were continually hatching from a plant. Our records, based on carefully made field counts, showed an average of 1,943 nymphs hatched from one plant during a ten weeks' period from July 23 to October 3. During this time the percentage of egg parasitism was relatively high, so that this does not represent the total number of eggs deposited, which must have been considerably greater. This gives an idea of the population of leafhoppers one potato plant may support during a season. The possible number per acre would thus run above ten millions.

These hatching records were obtained by a daily examination of six branches of potato plants and counting and removing the newly-hatched nymphs. This served as an index to the appearance and abundance of second generation young. August 6 hatching of second generation eggs was already taking place. This continued until frost in October, although at this time very few were found on the plants. It was noted that the greatest number of nymphs hatched out from August 20 to September 6, and that September 11 the number of nymphs hatching was greatly reduced.

LENGTH OF NYMPHAL LIFE

The average length of time spent in the nymphal stages for the first two was two days, for the third and fourth, three, and for the last,

TABLE IV COMPARATIVE LENGTH OF NYMPHAL INSTARS

Stage	Number of insects observed	Minimum	Maximum	Average
1	30	2	3	2
2	32	1	4	2
3	31	1	5	3
4	28	1	6	3
5	33	3	8	4
Total	154	8	26	14

four. A minimum length of time between molts was one day, as noted for the second, third, or fourth instars, during July, while a maximum of eight days' duration for the fifth was observed during October.

The duration of the nymphal or larval period varied greatly during the different months. In July the insect spent only a week maturing while in September and October, due to cool weather, the nymphal stage was prolonged to twenty-six days. This gave a minimum of fourteen days during July as the cycle from egg deposition to adult and a maximum in September and October of forty days. Thus the total life cycle was ten weeks for the first and over a year for the second generation.

CONTROL OF THE POTATO LEAFHOPPER (EMPOASCA MALI LE B.) AND PREVENTION OF "HOPPERBURN"[1]

By JOHN E. DUDLEY, JR., *Scientific Assistant, Bureau of Entomology, U. S. Department of Agriculture*

INTRODUCTION

Although periodic outbreaks of a leafhopper, probably the potato leafhopper (*Empoasca mali*), have occurred in this country since the early eighties, the insect's association with a disease of potato has just been established by Ball.[2]

As with most insect borne diseases it is the disease which we dread far more than the primary feeding injury of the insect involved.

The summer of 1919 was a most opportune time to undertake studies of disease transmission and control of the potato leafhopper. The infestation and accompanying disease had been severe in 1918, promising to be equally as bad the next year. Evidence that a disease formerly included in the term "tip burn" was transmitted by the insect had just appeared. Therefore, the problem was attacked in earnest and all possible data secured on the study of the insect itself, its relation to various hosts, and the effect of treatments used against it. Special emphasis was placed on the phase of most economic importance—transmission of disease and control.

DISEASE TRANSMISSION

The first outward indication of the disease, "hopperburn" (Plate 9), is a slight yellowing, usually at the tip of a leaf, followed by curling

[1] Published by permission of the Secretary of Agriculture.

[2] Ball, E. D., "The Potato Leafhopper and the Hopperburn That It Causes," in Wisc. State Dept. of Agric. Bul. No. 20, 1918.

Leaf of Green Mountain potato plants, showing typical brown curled tip and margin (×20)

and browning. This curling and browning preceded by a diseased, yellow area may spread from the tip or margin inward, eventually reaching the midrib when the leaf dies. The lower two-thirds of the midrib with a narrow green area on either side is the last to be killed, often remaining green for weeks after the spread of the disease to the entire plant.

In hot dry weather the disease usually spreads rapidly and whole fields of early potatoes have been killed in a week's time. On the other hand, if the weather is cool and moist, or if protective sprays have been applied, the disease may be checked and throughout the summer show nothing more than its early symptoms.

The potato leafhopper visits many plants but appears to reproduce on but few; potato, bean (string, pole, navy), hemp, apple, dahlia and hollyhock. A diseased condition with similar symptoms to the disease on potato has been found on the above plants, and on raspberry and box elder.

Laboratory Experiments

Laboratory experiments were conducted to study the effect of leafhopper adults and nymphs upon their several hosts, in relation to transmission of disease. It was found that in nearly all tests adults readily transmitted a disease. Nymphs did not transmit it in as large a proportion of tests as did adults. One adult or one nymph often sufficed to cause a plant to show decided symptoms of disease.

In one test four newly-hatched nymphs were placed on one of two healthy apple seedlings growing in a flower pot. In ten days the infested apple had become badly diseased, the uninfested one remaining green. In another test twenty newly-hatched nymphs were placed on a large healthy dahlia plant. Disease appeared in seven days, the plant dying in twenty days. A check plant remained healthy. These two are typical of many other tests.

Field Observations

During visits to potato growing sections of Wisconsin it was observed that, without exception when the disease was present the potato leafhopper was found; that when the disease was not present no leafhoppers were found. The extent of the disease as affecting both individual plants and whole fields was in close proportion to the number of leafhoppers present. An example is given: A field of Green Mountain potatoes on new land surrounded by woods had never been sprayed and, at first glance appeared uninfested by insects. Upon examining the field in detail, however, a leaf here and there was found showing a typically diseased tip. Without exception a leafhopper or cast skin could be found on or near every leaf thus affected.

Varietal Preference of Leafhopper or Varietal Susceptibility to Disease or Both

Different varieties of potatoes were attacked to different degrees by the potato leafhopper, and different varieties were affected to different degrees by the disease. The extent to which the same varieties were affected appeared to be much the same at widely separated points in the state. The Early Triumph variety was always affected worst; the Rural New Yorker variety always least and, moreover, in a given place, the Rurals were always attacked least by the leafhopper. The relative infestation on other varieties varied considerably.

It is believed that the leafhopper exhibits a preference for certain varieties of potatoes of tender foliage *and* that these same varieties may be more susceptible to disease than sturdier varieties of hardier foliage.

Plants of a Given Variety Vary Greatly in Amount of Disease

Observations the past season have shown that certain plants of one variety may have much greater resistance to disease than adjacent plants of the same variety. In a check (unsprayed) plot of Rural New Yorker potatoes three plants remained practically free of disease all summer, while the surrounding plants without exception became badly diseased. The same was true of a plot of Green Mountains.

Effect of the Disease on the Tuber

There are indications that the disease transmitted by the potato leafhopper seriously affects the potato tuber. Whether the actual organism of the disease gains entrance into the tuber, or the diseased foliage decreases the value of the tuber for seed, is yet to be determined.

It can be stated, however, that plants of the same variety but from different seed, growing side by side, exhibited decided and uniform difference in the amount of disease present. This difference was noted in two instances at one farm; two fields of Green Mountains were planted in blocks, each block being the seed from a different grower. All potatoes in each field were planted the same date. The degree to which plants in adjoining blocks were affected with disease enabled one to separate the blocks without looking at the end stakes.

In one field at Madison six varieties of potatoes were planted. Seed of five of the varieties came from reputable seedmen, and the plants treated with Bordeaux mixture stood off the disease throughout the summer. The sixth variety, Early Triumph, was seed from plants which had been killed by the disease the year before (1918). The plants from this seed were all killed by the disease early in the season despite thorough treatments with Bordeaux.

Is it possible that some condition due to disease may be carried over

winter in the seed potato, making it easily susceptible to disease when planted the following year?

CONTROL

All spraying was done with a wheelbarrow sprayer, the spray rod fitted with two adjustable arms and two adjustable, angled nozzles. All applications were directed upward at an average pressure of 150 pounds, the material thus being deposited on the under side of the leaves as is absolutely necessary.

KEROSENE EMULSION. One plot of Early Ohio and Green Mountain potatoes was sprayed three times with 10 percentage kerosene emulsion.

The infestation of adults was not noticeably reduced. Nymphs present at the time of spraying were readily killed, but great numbers continued to hatch and did not appear to be killed by any oil remaining on the leaves. There was no repellent effect observed upon adults or nymphs.

The Early Ohios were practically dead from disease by the last week in July. The Green Mountains were badly diseased by the middle of August.

The untreated rows of each variety were but little more diseased than those treated.

NICOTINE SULFATE. One plot of Early Ohio and Rural New Yorker potatoes was sprayed four times with nicotine sulfate 1-1200 and fish oil soap 2-50.

The treatments did not noticeably reduce the infestation of adults; eggs continued to be laid and young nymphs appeared without cessation. Nymphs present when the spray was applied were readily killed but no repellent effect was observed later upon either adults or nymphs.

Disease appeared in this plot a few days after the first spraying. On the Early Ohios the disease spread slowly but surely, until the first week in August, when all plants were practically dead. One row left untreated was at this time diseased to no greater extent than the treated rows.

The Rural New Yorkers, although as heavily infested all summer as the other potatoes, remained fairly free of disease. By the middle of August, however, the disease began to spread and in a week about half of each plant was dead. The untreated row was slightly more diseased than the treated one.

BORDEAUX MIXTURE. One plot of Rural New Yorker and Green Mountain potatoes was sprayed four times with Bordeaux mixture 4-4-50. The infestation of adults and nymphs in this plot was about the same as in the previous plots up until the middle of July. From

then to the end of the summer, however, there was a remarkable scarcity of both, especially on the Rurals. Newly hatched nymphs appeared every day but, strange as it may seem, disappeared in a short time. This repellent effect of Bordeaux has previously been mentioned by Fluke.[1]

Untreated rows of each variety in this plot were heavily infested with adults and nymphs throughout the summer.

Disease appeared after the second spraying on tips of leaves scattered all over the plot. No nymphs had hatched at this time. On the Rurals the disease remained without spreading to any extent until digging time. On the Green Mountains the disease spread very slowly and at digging time had not become serious, that is, probably not more than one-fourth of any plant had dead leaves.

On the untreated rows the disease spread without interruption from tip, to margin, to midrib, and all over the plants. At digging time Rurals showed some disease on every leaf; Green Mountains were badly diseased, many plants being dead.

Bordeaux Mixture and Nicotine Sulfate. Two adjacent plots of equal size were planted to six varieties of potatoes—Early Triumph, Early Ohio, Irish Cobbler, Green Mountain, Late Puritan and Rural New Yorker. One plot was given maximum protection with five applications of Bordeaux 4-4-50, combined for the two last treatments with nicotine sulfate 1-1200. The other plot received no protection against the leafhopper.

A very heavy infestation and frequent rains seemed at the time to demand five sprayings if maximum protection was to be afforded. It is probable, however, that four applications would have been sufficient.

During the early summer leafhopper adults and nymphs were present in about the same numbers as on other plots, but by the middle of July there was a great scarcity of both. A week later practically no nymphs and only an occasional adult could be found on the sprayed plots. This condition held up to digging time.

The unsprayed plot was at all times rather heavily infested with both adults and nymphs, the numbers increasing as the season advanced.

The treated plot immediately adjacent to a continual source of leafhopper infestation remained in excellent condition throughout the summer, the Early Triumphs being the one exception. (The seed of these came from plants killed by the disease the year before as previously mentioned). A slight amount of disease appeared on the

[1] Fluke, C. L., Jr., "Does Bordeaux Mixture Repel the Potato Leafhopper?" in Jour. Eco. Ent., Vol. 12, No. 3, 1919.

other varieties early in the season, showing principally on the tips of scattered leaves. Little more appeared and that present did not spread noticeably all summer, even during a period of hot dry weather. On Late Puritans and Rurals there was almost no disease; on the rest it was very light to light.

The untreated plot showed signs of disease early but, in contrast to the treated plot, the disease spread rapidly until midsummer when early varieties were about dead and the late ones were rather badly diseased. The Rurals, as in other plots, showed less disease at digging time than any other variety.

Thus the plot given maximum protection, in contrast to the plot given no protection, gave abundant evidence throughout the summer of the beneficial effect of spraying in relation to leafhopper infestation and the resultant disease.

Yields

The accompanying table shows the relative yields from each plot. No attempt was made to compare the yield from these plots with the average yield per acre in the state because the area around Madison is not adapted to potato growing and because fertilizers were not used on the plots. Yields from untreated plots were arbitrarily called 100 bushels.

Table Showing Yields

	Untreated rows	Treated rows
	Bu per acre	Bu per acre
Kerosene Emulsion Plot.		
Early Ohio	100	166
Green Mountain	100	125
Average...	100	146 5
Nicotine Sulfate Plot:		
Early Ohio	100	150
Rural New Yorker	100	200
Average..	100	175
Bordeaux Mixture Plot:		
Rural New Yorker.	100	200
Green Mountain.	100	196
Average....	100	198
Bordeaux-Nicotine Plot:		
Early Triumph...	100[1]	100[1]
Early Ohio	100	196
Irish Cobbler....	100	277
Green Mountain..	100	233
Late Puritan	100	217
Rural New Yorker ...	100	185
Average....	100	221 6

[1] Practically no marketable potatoes. Not included in average.

It is seen from the table that the treated rows gave much higher yields, ranging from one-fourth higher with Green Mountains, sprayed with kerosene emulsion, to two and three-fourths times as high with Irish Cobblers, sprayed with Bordeaux-nicotine.

However, as the four plots were widely separated and varied as to soil and previous manuring, the relative yields are not as indicative of the best spray as was the amount of disease which existed on the foliage.

Rural New Yorkers showed less difference in yield from three kinds of treatment than any other variety. They were also diseased less than any other kind. That it payed to spray them, however, is clear.

Number of Applications Necessary

It is believed that at least three applications, and preferably four, should be made. The first should be applied when leafhoppers have come in numbers.

The second spray should be applied in from ten days to two weeks from the first. Potato plants are growing rapidly at this time, offering new foliage to leafhopper attack. Frequent rains may be expected in some sections of the country, and will wash off much of the material.

The third spray should usually be applied about two weeks after the second, the exact time depending upon the amount of new growth infested, abundance of leafhoppers, weather conditions. (Hot dry weather is very favorable to rapid spread of the disease.)

A fourth spray might well be given to advantage when some of the following conditions exist: a hot dry summer, heavy new growth in late summer, great abundance of leafhoppers, desire to control certain other potato diseases.

When leaf-eating insects occur with the potato leafhopper, an arsenical can usually be combined with one or more of the Bordeaux sprays.

Enemies

Two enemies of the potato leafhopper were in evidence during the past season. One, a hymenopterous parasite, probably a Dryinid, attacked leafhopper eggs. It occurred in too small numbers to be of practical benefit.

The other enemy, a fungus (*Entomophthora sphaerosperma*), attacked both adults and nymphs. It was common all over the state and in northern sections greatly reduced the infestation.

Conclusions

Of three materials tested by themselves, Bordeaux gave by far the best results in leafhopper control and disease prevention. The yield

from this plot was greater than the next nearest plot by an average of twenty-three bushels.

Bordeaux combined with nicotine gave better results, as would be expected, than Bordeaux used alone. From the excellent results secured with Bordeaux used alone, however, it is doubtful if a combination will be necessary in the future.

The yield from the Bordeaux-nicotine plot would indicate that this combination controlled the insect and disease much better than did Bordeaux used alone. However, the former plot was on rich, recently manured ground, while the latter plot was on poor ground.

From a standpoint of prevention of disease on the foliage, the two treatments appeared of equal value.

INJURIES TO BEANS IN THE POD BY HEMIPTEROUS INSECTS[1]

By I. M. Hawley, *Ithaca, N. Y.*

During the past four years many samples of beans have been received at the Cornell Station, that have showed deformations varying from circular depressed areas with a dark spot in the center, to ragged holes in which the bean coat is badly ruptured. The name of "dimples" has been applied to these scars. As these markings bear a strong resemblance to Hemipterous punctures on other plants, specimens of *Adelphocorus rapidus* Say, one of the most common Mirids in western New York bean fields, were caged over a potted bean plant on August 15, 1918. When examined on September 4, the pods on this plant were mis-shapen and covered with dark, raised wart-like areas (Pl. 10, fig. 2). The seed in these pods showed evidence of dimpling (Pl. 10, figs. 1 and 3).

In the summer of 1919 an effort was made to verify this observation and to find other insects that might have a share in the work. On August 11, a cage containing *A. rapidus* was placed over two bean plants, the pods of which were still green. When these were examined on August 28, most of the beans were dimpled. One hundred pods picked near the cage contained only one dimpled seed.

The feeding of *A. rapidus* frequently produces such ragged, discolored marks on the bean seed, that it would seem that the insect in addition to removing juices from the bean, possibly secretes a toxin that acts on the bean tissues. The nature of the puncture appears to be influenced by the stage of development of the bean at the time of attack. The

[1] Contribution from the Entomological Laboratory of Cornell University.

seed is stunted when punctured and the growth around the injured portion produces the dimple. Beans on plants whose pods are still green, though nearly mature, tend to suffer most.

In the summer of 1918 immature beans in the field were pricked through the pod with a small insect pin and the plants marked by a tag. At harvest time the seed in these pods was dimpled, but in most cases the pits were more regular in outline than in the case of insect punctures (Pl. 10, fig. 3).

It is not always easy to pick out pods which contain dimpled beans by their outward appearance. The pods may be free of the roughened brown areas and still contain abnormal beans. Some have been found where a dark green spot on the lighter green of the pod was the only evidence of the deformation within.

Other insects that produce pits in beans are the spined tobacco bug (*Euschistus variolarius* Palisot de Beauvois) of the family Pentatomidæ and the tarnished plant bug (*Lygus pratensis* L.). Specimens of the first mentioned insect placed with beans on August 19 had produced small pits by September 8 (Pl. 10, fig. 1). Nymphs and adults of the tarnished plant bug left with a plant for nineteen days also produced small dimples (Pl. 10, fig. 1). The work of the latter was previously reported by G. C. Davis from Michigan in 1897. During late summer both of the above insects together with the apple leafhopper (*Empoasca mali* LeBaron) have been found in the field with their beaks inserted in the pods. Cage experiments seem to show however, that the beaks of the leafhoppers are too short to penetrate the pod and injure the beans within. Injury is especially noticed in places where ragweed and lambs quarters are allowed to grow.

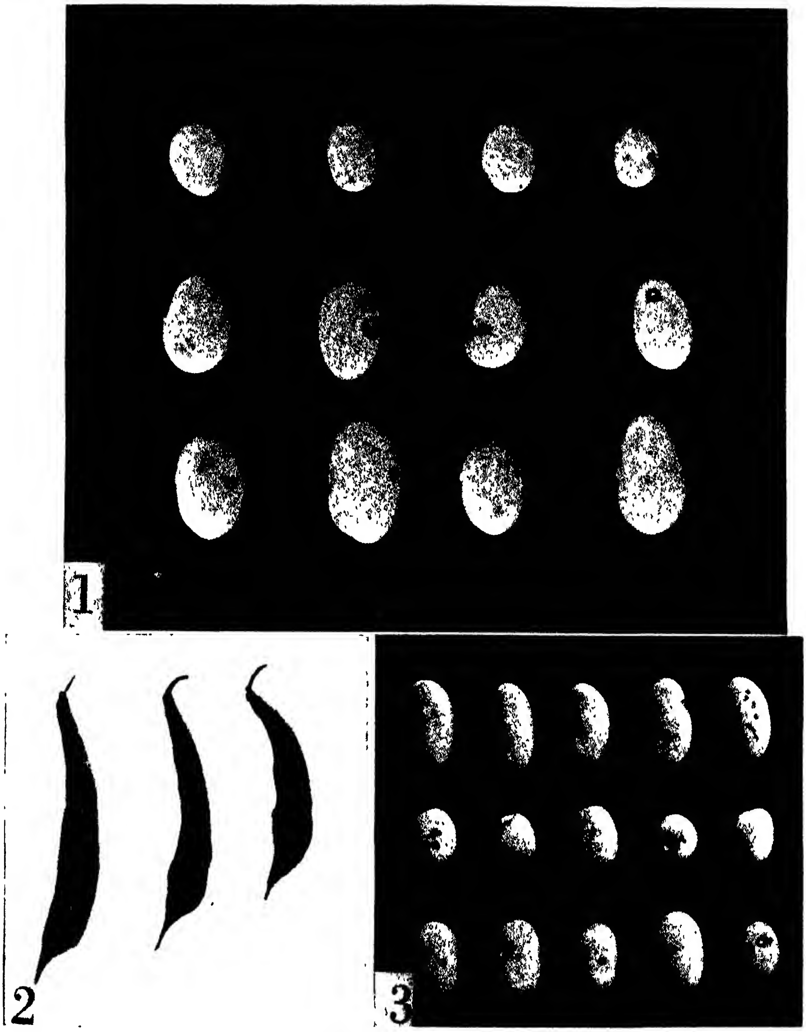
The extent of the damage caused by these pests is not great, but each year there are some beans of this kind in the product of many fields and gardens. The most disfigured of field beans will be discarded with the diseased and immature seed, when they are picked in the warehouse. Small pits might be easily over-looked, but beans with the ragged scars often resulting from the feeding of *A. rapidus* would surely be discarded.

THE SQUASH BUG[1]

By F. M. Wadley, *U. S. Bureau of Entomology*

The common squash bug, which is a well-known enemy of squashes and pumpkins, is said to be found practically everywhere in the United States, and in Mexico, Central America and Canada. The

[1] *Anasa tristis* De Geer, Family Coreidæ, Order Hemiptera.



1. Beans showing punctures of Hemipterous insects—upper row by *Euschistus variolarius;* middle row by *Adelphocorus rapidus;* lower row by *Lygus pratensis.*
2. Bean pods punctured many times by *Adelphocorus rapidus.*
3. Dimpled or punctured beans. The beans in the lower row were pricked in the pod by an insect pin while still green.

work on which this article is based was done by the writer while in the service of the Federal Bureau of Entomology at Wichita, Kans., late in 1916 and in 1917 and 1918; and at Muscatine, Iowa, in 1919.[1]

Importance

Both adults and young, especially the latter, injure the plant by sucking its juices, and probably also by the toxic effects of their bites. Small brown spots mark the feeding places of nymphs on the leaves. Further feeding causes large leaf areas to assume a grayish discoloration and die. If the bugs are abundant enough, the whole plant wilts rather suddenly after the death of several leaves. Young seedlings succumb very quickly to squash bug attacks, but since the bugs are scarce early in the season this injury is slight. It is in late summer, when the weather is hot and dry, and squash bug nymphs numerous, that the worst injury occurs. After the vines are killed, bugs are found clustered on squash or pumpkin fruits sucking their juices. If its normal food plants are overcrowded or exhausted, the squash bug may attack other nearby cucurbits, but it is a serious enemy only to squashes and pumpkins. The quick growing summer squashes are especially favored.

Description

The adult is dark brown in general coloration. This effect is given by a yellow ground color, more or less densely dotted with black punctures; variations in density of punctures result in mottling. The antennae, and the membrane of the wing, are solid black. The dorsal surface of the abdomen covered by the wings, is crimson. Adults vary in length from 13 to 16½ mm. and in width from 4½ to 6 mm., averaging 15 and 5 mm. respectively. The female is slightly larger than the male. The newly hatched nymph has a bright green body with red head, thorax and appendages; but within an hour or so the red has changed to black and the green has deepened. These colors remain during the first instar, after which the nymphs are usually gray with black head and appendages. For a short time after each molt, the bug is green with red head and appendages. The nymph has an abdomen large in proportion to the rest of the body, giving a pear-shaped appearance. The wing pads are conspicuous in the later instars. Both nymphs and adults are characterized by a strong sickening odor, common among Heteroptera.

The egg is whitish when first deposited but soon becomes a metallic shining brown. It is about 1½ mm. in length and a modified oval in

[1] During 1918 some of the work was done, under the writer's direction, by Mr. F. M. Liggett. Some of the data on hibernation were taken from the notes of the late Mr. H. O. Marsh.

Table I.—Sizes of Nymphs in Different Instars

Stage	Length of antennæ	Beginning of instar		End of instar		
		Length	Width	Length	Width	(The greatest width is about the middle of the abdomen)
1	2	2¼ mm.	1¼ mm.	.	. . .	
2	3	3 mm.	1½ mm.	4 mm.	2 mm.	
3	4	5 mm.	2 mm.	. .		
4	4 5 to 5	8 mm.	3½ mm.	9½ mm.	4½ mm.	
5	4 to 7	9 5-10	4 to 5 mm.	13–14.5	7 mm.	

shape. Viewed from either side or the bottom it has a round triangular outline, being compressed from these three directions.

Development

Adults. Those bugs which pass the winter live as adults for nine to twelve months, while others may die the same season they are hatched, after an adult life of a few weeks. The adults fly readily and strongly in the spring when finding food plants, and in the fall when seeking winter quarters. Through the active season they seldom fly, but remain close to the food plants, feeding, mating and ovipositing. They are inactive at night or in cool cloudy weather.

The squash bug has a reproductive period of several weeks; one female having deposited eggs for slightly over two months. Reproductive activities are limited to warm weather with temperatures of 60° F. or over. Reproduction begins under favorable conditions five or six days after the bugs become adult, and continue until death or cool weather. A number of females have deposited an average of ten eggs a day throughout the reproductive period. The eggs are placed in clusters of a few to forty-five, averaging fifteen, usually on the under side of squash or pumpkin leaves, and sometimes on the upper side or on nearby objects. Each egg is glued firmly to the leaf. In 1918, 92 per cent of all eggs were deposited between 8 a. m. and 5 p. m.

Egg. The egg stage at Wichita varies from seven to nine days in hot weather, while egg periods of from ten to seventeen days are recorded for cooler weather early and late in the season. Chittenden records the egg stage at Washington, D. C., as from eight to thirteen days, and Weed and Conradi state that in New Hampshire it varies from six to fifteen days.

Nymphs. Nymphs are very gregarious and are greedy feeders. The smaller nymphs are found in bands on the under side of the leaves, while the larger nymphs frequent the stems, as do the adults. The nymphs scatter when their food plants die, but can probably not go far before succumbing to hunger. Pot cages were relied on for data on length of instars in individuals, while large numbers of nymphs

were reared in cloth-covered cages in the garden for total nymphal life. The periods in pot cage rearing are perhaps a little longer than normal, as the nymphs did not thrive as well as in the larger cages. Dr. Chittenden has found nymphal instars at Washington to require 3, 8 or 9, 7 or 8, 6, and 8 days respectively, totalling 33 days. Weed and Conradi report that the instars require 3, 9, 8, 7 and 9 days respectively, with a total of 36 days, in New Hampshire. The figures secured at Wichita are given in Table II below.

TABLE II.—LENGTH OF INSTARS

Stage	July and early Aug., hot weather			Late Aug. and Sept., cool, nights chilly		
	Number specimens	Average length	Variation	Number specimens	Average length	Variation
1st	14	2.14 days	2 to 3 days	5	5.2 days	4 to 7 days
2nd	10	6.2 days	4 to 8 days	4	9.25 days	8 to 11 days
3rd	4	8.1 days	6 to 11 days	1	13 days	....
4th	(1)	(14)	....	2	10 days	9 to 11 days
5th			....	1	12 days	....
Total		30.44	26 to 36 days		49.45 days	46 to 56 days
Cloth covered cages		28 to 30	22 to 34 days			

One nymph reared in hot weather required fourteen days for the fourth and fifth stages combined, the fourth molt being overlooked. It can be seen that these two stages must cover fourteen days or less in summer if the length of the first three instars combined is compared with their average nymphal life. In October, with frosty nights, one nymph required twenty days for the fourth instar while another in the fifth instar lived seventeen days without molting.

SEASONAL HISTORY

The squash bug in southern Kansas has, besides the first summer generation, a large, but not complete second generation, and a small third generation. In east central Iowa there is a small second generation but no third. The bugs increase rapidly during the active season, but this is short owing to their temperature requirements. There is probably a large or small second generation throughout the corn belt, and in the South three or more generations may be expected. The common statement that but one generation develops seems based on the work of Weed and Conradi in New Hampshire, which was accurate, but not representative for most of the country. Slingerland, Gillette, Sirrine, Smith and Garcia, have stated as their belief that more than one generation develops.

OVER-WINTERED GENERATION. Only adults survive the winter in most of the United States, though it seems likely, from the temperature nymphs endure in the fall, that they might winter successfully

in the extreme South. General activity begins with the first warm summer weather early in June. While some bugs die early, most of them live until about August 1 or later. In 1918 one female lived until August 28. Egg production continues with little diminution until death. In 1917 over-wintered females deposited on the average 502.5 eggs each; in 1918, 419. In the latter case totals were reduced by the escape of several females early in the season, daily averages for 1918 giving a seasonal total of 634 eggs per female. These average totals exclude the few which died early in the season.

Table III.—Average Egg-Production of Over-Wintered Females

Period	Eggs per female per day	
	1917	1918
May 30—June 15	No figures	2 5
June 16—June 30	9 9	10 3
July 1—15	13 1	11 8
July 16—31	9 1	8 5
Aug. 1—15	12 1	3 6
Aug. 16—18	6 0	
Aug. 16—27		7 1
Average for period June 16–Aug. 18	10 4	9 0

Table IV—Eggs Produced in Each Month, Per Cent of Total

Month	1917	1918
May	0	1 4
June	24 3	30 8
July	63 4	54 2
Aug.	12 3	13 6

Summer Generations. The earliest of the first generation mature in July and the latest some time in October. In 1917 two females deposited an average of 356 eggs each before death late in August, averaging 9.6 eggs per female per day. Those maturing later produced fewer eggs, but about 80 per cent of the first summer generation became adult before September 1, or in time to produce some eggs.

The nymphs of the second generation are very numerous in late summer. The earliest of them become adult about August 20 at Wichita, and produce a few eggs. In 1918 four females of this generation produced a total of 335 eggs before ceasing; and averaged 8.4 eggs per female per day, from August 25 to September 3. Later individuals become adult throughout the fall and many perish from cold before maturing. The nymphs of the third generation are present at Wichita during the fall. Most of them probably perish before maturity. None have been known to mature, although one was reared to the fifth stage by October 5.

Fall Activities. The first cool nights about September 1 check activities. Bugs maturing after this neither copulate nor oviposit. Those already producing show a marked checking of reproductive activities, which cease within about two weeks. From the few individuals studied, it seems that the adults of the first generation which have produced many eggs, die before fall; but those adults which have pro-

duced only a few eggs, so far as is known, live and go into hibernation. Early in September adults begin scattering to seek hibernation quarters, while younger stages develop slowly on account of the increasing coolness. After the food plants are killed by frost many starve, while others collect on the fruits. Some nymphs mature and adults are usually present among the nymphs all fall. These adults, however, keep scattering. All remaining nymphs are finally killed by the cold. In 1917 a temperature of 14° F. killed all nymphs. The bugs are last seen in their summer haunts some time in November.

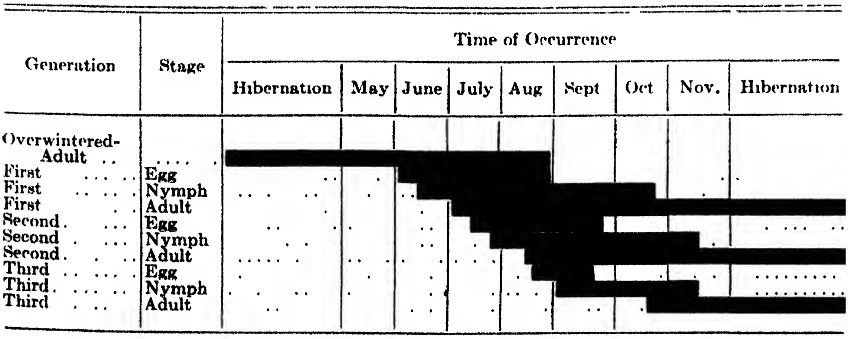
HIBERNATION. When dispersing, squash bugs reach all sorts of locations, such as buildings, tree trunks, brush and others. They have been found hibernating under boards, under a weed pile, and in bark crevices on the under side of a log. From a few to over fifty have been found hibernating in one location. Various workers mention hibernation in sheds, under boards, in wood piles, and among stones. At Wichita adults of the first, second and perhaps third generations may hibernate to appear again as the overwintered generation.

The shaded blocks in the diagram show the time of year a given stage is present while the dotted lines indicate the time it is not present.

TABLE V.—CALENDAR OF OCCURRENCE

	1917 (Kansas)	1918 (Kansas)	1919 (Iowa)
First adult seen	May 10	May 23	
First eggs seen		May 30	
Eggs abundant in field	June 20	June 15	
First nymphs hatched		June 13	
Adults first generation reared	July 12	July 6	July 28
Eggs from first generation	July 18	July 14	Aug 4
First nymphs second generation	July 27	July 23	Aug 17
First adults of second generation	Aug 20	Aug 19	Sept 19
Eggs from second generation		Aug 25	
Nymphs of third generation hatched	Early Sept	Early Sept	
Over-wintered females died	June 22, 23, 25, July 26, 31, Aug 13, 18	June 19, July 20, Aug 19, 28	
Last eggs deposited in cages	Sept 13	Sept 11	Sept 3
Last adult and nymphs seen in field	Nov 20		

TABLE VI.—DIAGRAM SHOWING STAGES PRESENT AT A GIVEN TIME



Natural Checks

Chittenden, Girault, and Weed and Conradi mention parasites of the egg and adult, a bacterial disease, and cannibalism as checks on the squash bug. These do not appear to be active under Kansas conditions, the principal checks on the species being lack of food and cold. Cool weather restricts activities, and all nymphs and many adults perish from winter cold. All the plants in a patch are sometimes killed by the bugs in late summer. Adults may fly to other feeding places, but nymphs must perish in thousands, before finding food. Where bugs have cut off their own food supply in this manner, they will usually not assume normal numbers in the locality until late the next year. Many nymphs starve in the fall after frosts kill their food-plants.

Control

General Considerations.—Control of the species is difficult when bugs are numerous, but it is not impossible. The methods found effective include cultural or preventive measures, and hand-picking and spraying, which are remedial measures. Other methods which have been advocated at times but not found practical, include the use of coverings for young plants, planting an excess of seed, fumigation under covers, the use of repellents, and burning bugs in the fall with a torch.

Cultural measures are valuable in restricting injury by squash bugs, other insects, and plant diseases, and will usually increase the crop even if no enemies are present. They should be used in all cases as far as possible. When squash bugs are present in injurious numbers, and the crop is of considerable value, remedial measures may also be employed. Hand-picking must be depended on in small garden plots, and may supplement spraying in larger gardens. Spraying is expensive, and is not warranted unless the crop is profitable, and the attack severe. It may be of value in large home gardens, or market gardens. Where squashes and pumpkins are grown on an extensive plan, and large returns are not expected, remedial measures cannot be profitable, but cultural measures should usually insure a fair crop.

Cultural Methods.—These include crop rotation, fertilization and thorough tillage, and clean farming in the fall. The first method aims at removing the crop from the vicinity where the bugs have developed the preceding season, and where observation shows that their work begins earliest and is most severe. It is efficient in large fields. The second method aims at stimulating plant growth so as to give a good yield in spite of some injury. Clean fall culture is very important, as the fruits left on the ground nourish many bugs

that would otherwise perish, and encourage hibernation in the vicinity. All fruits should be gathered early, the vines cleaned up, field thoroughly plowed, and brushy and weedy borders cleaned up. Neglect of such measures will greatly increase the number of bugs in the vicinity the following season, as observation has shown.

HAND PICKING.—The plan is to prevent development of squash bugs by removing all adults and eggs from the plant early in the season. The method is very laborious and will not altogether prevent injury; but if carried on throughout the season a fair crop can be secured in spite of the bugs.

TEST OF CONTACT INSECTICIDES.—In the fall of 1916, squash bugs were dipped in various contact insecticides to give an idea as to their efficiency. The more effective insecticides were then tested out in the field, by spraying a small area on which bugs were congregated, and confining them on it with a screen cone. The bugs were given a chance to dry, and kept twenty-four hours under favorable conditions, as determined by a check, when the living and dead were counted. The results are given in Table VII.

TABLE VII

Solution used	Laboratory		Field	
	No bugs used	Per cent killed	No bugs used	Per cent killed
Fish-oil soap, 0 4 to 0 5 pounds per gallon	40	75	47	70
Same, plus "Black Leaf 40," 1 to 1,000	20	95	68	66
Same, plus "Black Leaf 40," 1 to 500 .	20	90		
Same, plus "Black Leaf 40," 1 to 250	20	100	121	83 5
Same, plus sulphur, 1 or 2 ounces per gallon	40	97 5	168	91.70
Fish-oil soap, 0 2 pounds per gallon . .	30	60		.
Same, plus "Black Leaf 40," 1 to 1,000 .	20	95	61	57
Same, plus "Black Leaf 40," 1 to 250 .	20	85		.
Same, plus sulphur, 1 or 2 ounces per gallon	10	60		.

These figures are for adults, the solutions used all being deadly to nymphs. A strong soap solution with sulphur in suspension has given the best results of any spray yet tested against the squash bug. Nicotine sulphate is less effective in the field, though promising in laboratory tests. The sulphur makes trouble by clogging nozzles and settling, but its advantages more than offset these drawbacks. Tests in 1917 confirmed these data, and also showed that nymphs succumbed to fish-oil soap at 0.2 pounds per gallon, sometimes to even weaker solutions; that sulphur much increased the effectiveness of the soap against nymphs as well as adults; that sulphur paste alone will not harm squash bugs; that strong soap solutions will not affect the eggs; and that squash plants suffer little or no injury from fish-oil soap solutions

of the strengths used. A soda-sulphur compound, made up like lime-sulphur, was tested, but seemed unpromising.

In 1917 a small plot of squashes, severely infested with bugs, was sprayed July 18 and again August 2. Fish-oil soap, 0.2 pounds per gallon, without sulphur, was used. The infestation was checked, the plants recovered and bore a good crop; however, the bugs reached injurious numbers again in September. In 1918, one-sixth acre of squash and pumpkins was sprayed during the last week in July, using soap, 0.25 pounds per gallon, and sulphur, 2 ounces per gallon. The infestation was moderately severe and was causing some injury. The spraying was a complete success, no second application being necessary, and bugs were very scarce the rest of the season.

Spraying.—We would recommend fish-oil soap, 0.25 pounds per gallon, with sulphur, as an efficient spray. The soap is hard to obtain in many places, but may usually be ordered from distributing centers. A good hand sprayer, with extension rod and angle nozzle, has given good results. A larger sprayer might be arranged for this work, but a man must handle each spray rod, as little could be done with fixed nozzles. Care must be taken to keep the sulphur suspended. Spraying should be postponed until nymphs are numerous and severe injury seems threatened. If it can be avoided altogether, and a good yield secured, so much the better. If the grower sprays in early or mid-summer, the bugs are almost sure to assume injurious numbers again before fall. In Southern Kansas, if spraying can be postponed until July 25 or later, injury will usually be eliminated for the rest of the season. Some adults and all eggs will escape the spray. Adults and eggs are scarcest late in July, when many over-wintered adults have died, and few of the first generation have matured. A coarse driving spray should be used, spraying first under the leaves, then on the larger stems. Wherever groups of bugs are found they should be thoroughly drenched, lifting stems and fruits if necessary, and directing the spray against bugs on the ground as they leave the plants. The bugs surviving will scatter, and re-assemble in a few days. If these are numerous, and if many eggs were present, a second spray ten days later may be desirable. This will take less time and material than the first, as the groups of bugs will be much fewer. The expense of such spraying is considerable. In experiments it has required one man about thirty hours to spray an acre, and the thorough application necessary will require 300 to 400 gallons per acre. Under 1918 conditions, the cost of spraying an acre was about $25; under 1914 conditions it would be about $15. It should be kept in mind that a patch of squashes or pumpkins grown intensively usually occupies only a fraction of an acre.

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BROOM CORN, THE PROBABLE HOST IN WHICH PYRAUSTA NUBILALIS HUBN. REACHED AMERICA

By Harrison E. Smith, *U. S. Bureau of Entomology, Corn Borer Laboratory, Arlington, Mass.*

Since the introduction of the European corn borer, *Pyrausta nubilalis* Hubn., into America, there has been a very considerable interest as to the manner in which this insect may have reached the eastern shores of the United States. Most of the published statements have indicated raw hemp imported from southern or central Europe as the possible food plant in which the European corn borer obtained entrance into this country.

At a public hearing held by the Federal Horticultural Board at Boston, Mass., August 15, 1919, Professor George G. Atwood, chief nursery inspector for the state of New York, made the following statement:

"This is a good time to give the theory we have. We believe that you had the corn borer here in Massachusetts two years, perhaps, before we. We think there were no corn borers in the state of New York previous to seven or eight years ago, probably ten. We do know that about eight years ago broom corn was imported from Austria and taken into the city of Amsterdam where it was manufactured into brooms, and the waste from the factory was thrown out, given away and scattered along the Mohawk River. Now, the prevailing winds are mostly from the West. Scouting so far has revealed about ten miles west of the city of Amsterdam in a narrow valley of the Mohawk River the presence of corn borer but very slightly, but ten miles going down from Amsterdam to Mohawk for a distance of ten miles there is a strip about a mile wide on both sides of the river down to the city of Scotia. My theory is that waste from the infested section in Amsterdam was distributed either by the northwesterly winds or with the floods. We had floods that covered hundreds of acres just west of Schenectady. That is where we have the thickest part of our infestation. We fully believe that the introduction of broom corn at Amsterdam was responsible for the presence of the insect. As far as the spread of the insect in New York is concerned we have been unable to find anything east of the Hudson River.""

As a result of Mr. Atwood's statement, the records of importation of broom corn were looked up. The following data showing the amounts and the origin of the broom corn imported into the United States for the years 1909 to 1918, inclusive, have been compiled from the report of the Bureau of Foreign and Domestic Commerce, Department of Commerce:

Year	*Country*	*Tons*
1909	Austria-Hungary	1,097
	Germany	601
	Italy	181
1910	Austria-Hungary	3,007
	Belgium	2
	England	1
	France	1,574
	Germany	67
	Italy	2,213
	The Netherlands	90
	Russia in Europe	53
	Turkey in Europe	382
1911	Austria-Hungary	425
	Belgium	9
	Germany	52
	Italy	89
	Roumania	21
	Russia in Europe	7
	Turkey in Europe	13

Year	*Country*	*Tons*
1912	Austria-Hungary	646
	France	6
	Germany	10
	Italy	609
	Roumania	39
	Russia in Europe	28
1913	Austria-Hungary	67
	Italy	9
	Russia in Europe	2
1914	Austria-Hungary	537
	England	24
	Germany	104
	Italy	573
1915	Austria-Hungary	103
	Italy	1
1916	Italy	158
1917	France	$3.00 worth
1918	Italy	374
Total		13,174 tons

These facts seemed so significant that it became desirable to determine, if possible, the distribution of the thousands of tons of broom corn brought into this country during the previous nine or ten years, as indicated in the report of the Department of Commerce, and the writer was detailed to investigate the matter. The results of this investigation are given below. It will be recalled that the first record of the presence of *Pyrausta nubilalis* in America was from specimens reared from dahlia stems collected at Everett, Mass., during the summer of 1916. It seems significant that the point of collection of this infested material was but a short distance from two broom manufacturing concerns located in that city.

During the winter of 1909–10 the Lee Broom & Duster Company[1] at Everett, Mass., received 183,000 pounds of Austro-Hungarian broom corn shipped direct from Budapest, Hungary. Two shipments of a total of 92,000 pounds were landed at the Mystic Wharves, Chelsea, Mass., and a third shipment of 91,000 pounds was landed in New York and trans-shipped to Boston via the Merchants' S. S. Line. During the period December 1, 1911, to January 24, 1912, a shipment of 120,009 pounds of Italian broom corn was received from Florence, Italy. From December 26, 1911, to January 2, 1912, a total of 1,054 bales of Austro-Hungarian broom corn shipped from Bupadest was received at New York and transferred via water to Boston, thence to the Everett factory. Up to January 1, 1916, there still remained in

[1] The author is greatly indebted to Mr. Thomas H. Marsland who has furnished much information and many details of the broom corn situation during 1909 to 1914.

storage eighty bales of Austro-Hungarian broom corn from the 1911 importation, and a part of this broom corn was not used at Everett until some time after July 1, 1916.

Subsequent investigations continued in New York City made it possible to interview Mr. Wilson M. Toll, one of the largest jobbers and importers of foreign broom corn in the United States. During the season of 1909 the broom corn crop in this country was very short, and as a result of this condition Mr. Toll, early in the fall of 1909, left for Bupadest, Hungary, for the purpose of importing large quantities of the Austro-Hungarian crop into America. He purchased 1,000 tons of the 1909 Hungarian crop which was received in New York City during the winter of 1909-10. Upon receipt of this shipment at least two-thirds of the importation immediately was forwarded to the factories at Amsterdam, N. Y. A large shipment was made to Frankfort, Ky., and smaller shipments to Louisville, Ky., Rochester and Buffalo, N. Y., and other points. Mr. Toll also advised that at this time Canadian buyers purchased considerable amounts of Hungarian broom corn which went to Hamilton, Ontario, to be used by the large broom factories at that point.

During March, 1910, Mr. Toll imported 3,000 bales of the 1909 crop of Italian broom corn which was shipped direct from Venice to New York. This was disposed of to various factories of which no definite record is available.

On September 23, 1919, Mr. M. Dorn of the Frankfort Broom Company of Frankfort, Ky., was interviewed and stated that "between May 11, 1909, and June 16, 1909, he received from New York a shipment of 528,888 pounds of Austro-Hungarian broom corn all of which probably was manufactured into brooms within three months after receipt." Mr. Dorn was the first to import Hungarian broom corn into America, which original importation was made in the fall of 1899, when 400 tons were imported for use at the Frankfort factory and a Mr. Gross of Chicago imported 150 tons for use in that city. Mr. Dorn adds that "all of the broom corn in this importation of 550 tons was of the Hungarian crop previous to 1899 and that to his knowledge none of it was of the Hungarian grown crop of that year, and for this reason would not be apt to have been infested with the European corn borer."

Information relative to the Hungarian broom corn shipped to Louisville could not be obtained.

Amongst others of the American importers of broom corn who visited Budapest during the fall of 1909 was Mr. M. K. Kavanaugh of the Kavanaugh Bros. Broom Corn Company of Chicago, Ill., who imported 600 tons. This lot of broom corn was landed at New York

and Newport News, Va. Of this 600-ton importation more than 2,775 bales were received in Chicago between February 23 and March 2, 1910, whence it was sold in job lots as follows: 80 per cent of same to the some thirty manufacturing plants located in Chicago and its suburbs, and the remainder to establishments in Indianapolis, Ind., Milwaukee, Wis., Dubuque, Iowa, Toronto, Ontario, Montreal, Quebec, and numerous other points in the United States of which no definite record was obtainable.

It is apparent from the foregoing statement that the shipments of broom corn, which thus far it has been possible to trace, account for not more than one-third of the total tonnage of broom corn imported into the United States since 1909, as shown in the report of the Department of Commerce, and that the states to which it was shipped are as follows: Massachusetts, New York, Kentucky, Illinois, Indiana, Wisconsin, and Iowa.

Foreign literature dealing with *Pyrausta nubilalis* Hubn. apparently does not make specific note of this insect as being a serious enemy of *broom* corn in southern and central Europe, although it is well known as a serious pest of maize in that country. However, since it is known to infest broom corn under field conditions in Massachusetts and has fed voraciously upon that plant in the laboratory, it no doubt infests broom corn as grown in Austria-Hungary.

Our investigations to date made in the United States at a great many of the points where Hungarian broom corn is known to have been received for manufacture have failed to discover its presence except in the vicinity of Boston, Mass., Amsterdam, and Buffalo, N. Y. Hence, it seems a very significant fact that the three existing infested areas in Massachusetts and New York, as originally located, were in each instance within reasonably short distances of broom factories. In so far as the hemp theory is concerned, it will be recalled that it was based on the fact that the first located infestation in Massachusetts was not far from the Charlestown Navy Yard where considerable amounts of raw hemp are used in the manufacture of rope. At the same time, however, importations originating from identical sources were being made at Plymouth, Mass., some forty miles south, and at Andover, Mass., approximately twenty-five miles north of Charlestown, and yet no infestations of the European corn borer in the vicinity of either of the two latter places were discovered until the summer of 1919. This situation gives rise to a very considerable doubt as to the validity of the hemp theory in its relation to the original Massachusetts infestation, and would appear to indicate the greater possibility of broom corn used at the Everett factory as being the vehicle in which the pest reached this country. Assuming that the broom corn im-

ported from Austria-Hungary was infested when it reached America, there would seem to have been ample opportunity for the adults to escape because much of the material remained in storage and was not manufactured until some time after the normal dates of spring emergence under our climatic conditions.

The fact that this insect is not now known to be established in any of the other numerous points in America where Austro-Hungarian broom corn was shipped may be due to several causes, one of which is an incomplete survey of the suspected regions. Thus, the data obtained upon this phase of the European corn borer situation to date appear to indicate rather forcibly that broom corn was the vehicle in which the European corn borer reached America.

BEAN LADYBIRD

By W. E. Hinds, *Entomologist Alabama Experiment Station*

For many years the bean ladybird, *Epilachna corrupta* Muls., has been known to occur in Arizona, New Mexico, Colorado, and to a very limited extent in some adjacent states, where serious damage has been done to all varieties of table beans. The injury to the crop has been frequently very severe, but the spread of the pest has seemed to be slow and but little damage was done in the Plains region. Under the climatic conditions in that territory, two generations occurred and control measures consisted principally in jarring the insect from the plant to the hot, dry ground. Insecticidal measures gave little relief and appeared to act mainly as a repellent rather than insecticide.

No occurrence of this insect East of the Mississippi River was known to us until specimens of the pest were received at the Alabama Experiment Station in July, 1920, from Jefferson and Bibb Counties, Alabama. Since that time a number of reports indicate its occurrence through a considerable area and scouting work conducted about the 20th of August revealed the fact that the pest has been present in the vicinity of Blocton, Ala., in Bibb County, where it was first noticed in July, 1918. The first appearance of the pest in Jefferson County seems to have been within the city limits of Birmingham in July, 1919. During that season many truckers lost their late crop of beans but made no report of the occurrence of an insect pest to the Experiment Station or to any person realizing the danger of this insect becoming established.

At the present time the pest occurs throughout Jefferson County and extends into adjacent counties, particularly southwestward to Bibb County. The second generation is now becoming adult during the latter part of August and the insect is likely to continue its spread

considerably before the end of the season. We have no information as to the limit of flight.

An important new food plant record is found in the occurrence of the beetle in all stages upon cowpeas in one locality. It remains to be seen whether cowpeas will constitute a favorable food plant. The growth of cowpeas and soy beans is quite extensive in this section of Alabama and large truck farmers around Birmingham are deeply interested in the production of all varieties of table beans. The problem appears, therefore, a serious one for this section and it is possible that the insect may spread widely throughout the southeastern states. It has demonstrated its ability to withstand ordinary climatic, winter conditions in north central Alabama and has flourished under our summer climatic conditions. The further spread of the pest will be watched closely and an investigation of life history and field control has already been started.

It would appear that the introduction of this pest had occurred in commercial shipments, either of alfalfa hay or of beans and possibly with both materials produced in the infested territory in Arizona, New Mexico and Colorado. The possibility of exterminating the pest would appear to be slight at this time, and methods of control will, therefore, be sought as rapidly as possible.

Scientific Notes

The European Corn Borer in Canada. On August 10, the European corn borer was discovered for the first time in Canada. Larvæ about half an inch in length were found on that date near Lorraine Station, Welland County, Ontario, by Messrs. Keenan and Simpson of the Division of Foreign Pests Suppression. The infestation at this point was light but more eastward, particularly in the vicinity of Ridgeway and Chrystal Beach, Ont., the infestation was heavier. Larvæ collected at these three points were determined by Dr. J. H. McDunnough, chief of the Division of Systematic Entomology, as *Pyrausta nubilalis*, and this determination has since been confirmed by Mr. D. J. Caffrey, in charge of the European Corn Borer Laboratory, Arlington, Mass.

Since these first infestations were discovered, Mr. L. S. McLaine, chief of the Division of Foreign Pests Suppression, has undertaken much further scouting in other parts of Ontario and this work is still under way. From present knowledge Mr. McLaine has given me the following statement:

"When the borer was discovered at Ridgeway and Chrystal Beach an effort was made to find the limits of the infestation. According to latest advices this extends from Fort Erie on the east to Dunnville on the west along the Lake Erie shore and about twenty miles inland. On August 23, larvæ were received from a farmer, living near St. Thomas, Ont. Scouts were immediately despatched to this new infestation and their first report indicated that 5 per cent of the corn plants in the fields examined were infested. The infestation in western Ontario has not as yet been defined, but on September 16 it composed all of Elgin and Middlesex counties and a portion of Oxford County."

On the above date (September 16) an important conference took place at St. Thomas, Ont., at which the following men were present: Messrs. W. R. Walton and L. H. Worthley, of the United States Bureau of Entomology; Dr. E. P. Felt, state entomologist of New York; Dr. J. H. Grisdale, deputy minister, Dominion Department of Agriculture; Prof. L. Caesar, provincial entomologist, Ontario, and Messrs. Gibson, McLaine, Keenan and Vroom of the Dominion Entomological Service. Fields of field corn in the vicinity of St. Thomas were investigated, some of which were very seriously infested, in one field probably a commercial loss of from 20 to 25 per cent had resulted.

ARTHUR GIBSON

Acting Dominion Entomologist, Department of Agriculture,
Ottawa, Canada

The Green Japanese Beetle (*Popillia japonica*), which was discovered in New Jersey several years ago and which has been confined to that state, is now known to occur in Pennsylvania along the Delaware River for a distance of nearly eight miles and extending back from the river one-fourth to one and one-half miles. The Pennsylvania infestation was first discovered in July, 1920, by Mr. Fred Worsinger, a scout for the Pennsylvania State Department of Agriculture. Beetles were first found in Pennsylvania at Torresdale and here the beetles are most abundant and that location is apparently the center of the Pennsylvania infestation.

The conditions in Pennsylvania are apparently ideal for the beetle and there is reason to believe that it will increase and spread at the same rate as in New Jersey.

Just how the beetle became established in Pennsylvania is problematical. The supposed center of infestation is at Torresdale and up the river from the nearest known 1919 infestation in New Jersey. It is not, therefore, likely that the beetle flew across the river. A club house in New Jersey within the infested area affords considerable traffic across the river, particularly during the summer months when the beetles are active. Weeds and rubbish are sometimes carried up the river with the tide from the New Jersey shore to the Pennsylvania side. Either of these last two possibilities are likely methods of transportation.

Although some scouting was done in Pennsylvania in 1919, there is little doubt that a few beetles occurred on that side of the river a year ago.

JOHN J. DAVIS.

Riverton, N. J., Sept. 2, 1920.

Round-Headed Apple Tree Borer Injuring Apple Fruits. On July 20th, while inspecting an orchard near Scotland, Pa., the writer observed a considerable number of large feeding scars on apple fruits. At first it was somewhat puzzling to state the real cause of the damage, but after a more thorough search the real culprit was found to be the adults of *Saperda candida.*

These feeding punctures were frequently 5 to 10 mm. in width, 10 to 20 mm. in length and 1 to 2 mm. in depth. In some instances the fruit was marked by trough-like gouges 4 mm. in width and 8 to 10 mm. in length. The work of this beetle may be determined by the rather large serrate margins of the feeding scars, this being caused by the sharp, pointed mandibles. Not infrequently the surface of the fruit bears string-like frass particles, 3 to 6 mm. in length.

The amount of feeding in this orchard was considerable as most of the tree trunks were badly infested with borers.

Under laboratory conditions the adult beetles caused injury to fruits similar to the injury observed in the field thus proving conclusively that the adult borer was re-

sponsible. It was also noted that the beetles when confined exclusively with apple fruits oviposited in them.

J. L. King.

Chambersburg Laboratory,
Pennsylvania Bureau of Plant Industry.

Flea-Beetle Injury to Apples. A species of flea-beetle, identified as *Nodonota puncticollis* Say, has caused considerable injury in a few apple orchards in the vicinity of Chambersburg, Pa., during the season of 1920.

The beetle was first noticed on the apple foliage in a weedy orchard on the 2nd of June. At that time slight feeding injuries were observed on the leaves but none on the fruits. On the 14th of June, however, the writer received a hurry call to visit an orchard where "bugs were eating up the apples" and found upon entering the orchard that the report was not greatly exaggerated and that the flea-beetle was responsible for the damage.

The injury was mostly superficial, the skin of the apples being chewed away in places and then small shallow pits eaten out of the flesh In many cases, however, rather large cavities were eaten in the apples and especially so where apples were in contact with each other. Feeding injury was also noted on the leaves and in a few places the leaves were brown in color due to the many small areas of leaf surface which had been eaten away.

To prove whether the injury to the fruits was primary or followed some other insect injury or abrasion the writer caged specimens of the beetle with perfect apples and found that while the beetles preferred to begin feeding where the skin was broken, they were not deterred by perfect fruits.

Flea-beetle injury was noted subsequently in a number of orchards but in only the one orchard was it thought serious enough to require a controlling spray of Bordeaux mixture and arsenate of lead. As for the effects of the spray it was impossible to judge definitely due to the lateness of the application. In all cases, orchards showing injury were more or less neglected and weedy. During the remainder of June numbers of the beetles were observed on most of the common weeds along the roadsides and in the fields.

J. R. Stear.

Chambersburg Laboratory,
Pennsylvania Bureau of Plant Industry.

Frenatae, the Entomological Club of the University of Minnesota holds regular meetings every Tuesday, throughout the year, at 4.30 p. m. in the entomological laboratories, University Farm, St. Paul. During the summer special field trips will be arranged. Any entomologists visiting the Twin Cities are invited to attend and to take part in these meetings. Among the visitors and speakers of the past year have been—H. E. Ewing of the National Museum; W. E. Dove, Bureau of Entomology; T. B. McGath, Mayo Institute; H. E. Strickland, Canadian Entomological Service; Professor H. L. Osborn, Hamline University, and Professor Sadao Yoshida, Osaka, Japan. Dr. B. P. Lawson of the Entomological Department, University of Kansas will give the course in Elementary Economic Entomology in the summer school of the University of Minnesota. This work will be offered from June 21 to July 30. More specialized courses will be offered for various members of the department not only during the period of the regular session, but throughout the summer.

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The editors will thankfully receive news items and other matter likely to be of interest to subscribers. Papers will be published, so far as possible, in the order of reception. All extended contributions, at least, should be in the hands of the editor the first of the month preceding publication. Contributors are requested to supply electrotypes for the larger illustrations so far as possible. Photo-engravings may be obtained by authors at cost. The receipt of all papers will be acknowledged.—Eds.

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The recent discovery of large areas with a gipsy moth infestation of some years' standing and a similar find in relation to the European corn borer raises a series of interesting questions. Those familiar with the subject may recall that the gipsy moth maintained itself in this country practically unnoticed for twenty-two years, and the evidence at hand indicates that the European corn borer was probably introduced some ten years before its recognition. Furthermore, these records are by no means peculiar to these two insects or to certain infestations by one or both. The facts are that outbreaks by unknown insects largely escape attention unless of marked severity and even then may not be brought to official attention with desirable promptitude. This is due to two causes. It is frequently very difficult to decide in advance the true status of an importation, and in not a few instances the observer, if there be one, is unable to distinguish between an unusually abundant native species and a newcomer. The assistant farm bureau agents, working in some counties of New York state, will render material assistance along these lines since they give special attention to insect pests and plant diseases. County farm bureau agents are extremely valuable in the early detection of new insect pests. There should be, however, wider appreciation of the important part played by insects and this can be brought about only by more general knowledge of the group, not so much along systematic lines as in popular and practical ways. The general public should appreciate more fully the economic status of the group and come to have a sympathetic appreciation of the part played by the hexapoda in the scheme of nature. Not all are willing to become entomologists and it is not

advisable that they should. It is entirely possible for a very large proportion of our people to cultivate an appreciation of the various manifestations of nature and through such understanding put themselves in a position to more readily detect the unusual. This is especially desirable among agriculturists, though it should by no means be limited to one class. Attention is called to this matter because it is believed that all such agencies can and should be utilized in keeping watch upon the varied activities of insects, and in doing this we are engaged in one line of economic entomology.

Current Notes

Conducted by the Associate Editor

The Wolley-Dod Collection of Lepidoptera has been bequeathed to the Entomological Branch and arrived in Ottawa on June 23.

Doctor A. B. Cordley has retired as director of the Oregon Agricultural Experiment Station, but continues as dean of the School of Agriculture.

Mr. J. A. Flock, junior entomologist at the Strathroy Laboratory, Dominion of Canada, resigned on August 4 to go into commercial work.

The old insectary at Cornell University, built by Professor Comstock in 1886, has been torn down to make room for the new chemistry building.

Professor H. A. Gossard, Agricultural Experiment Station, Wooster, Ohio, spent his vacation in an automobile trip through northern Illinois and parts of Iowa.

Thousands of acres of hardwood forest land have been stripped by forest tent caterpillars in New Brunswick, the greatest damage occurring in the vicinity of Moncton.

Apanteles lacteicolor was again recovered from brown-tail winter webs collected in Nova Scotia. This recovery is quite gratifying as only a few nests of this pest were found last winter.

Mr. E. P. Felt, state entomologist of New York, was presented September 14, with a traveling bag by his associates on the State Museum staff in recognition of twenty-five years of service.

Mr. P. R. Lowry, a graduate of the Ohio State University, who was employed temporarily as assistant in the entomological department of the Ohio station in 1917, is again assisting the same department for the summer.

Professor R. D. Watt of the School of Agriculture, The University, Sydney, Australia, visited the Entomological Branch, Ottawa, Canada, the latter part of July and reported on the meetings of the Imperial Entomological Conference held in London, England, last June.

The Canadian Forest Insect Field laboratory has been moved from Fort Coulonge and will be placed near Queen's Park, Aylmer, P. Q., in a suitable location. The bark beetle control work in British Columbia is practically completed for this season. Mr. Hopping is now supervising the final work including burning the slash from the winter's cutting operations. Mr. Dunn has taken charge of a party on the spruce budworm survey in New Brunswick. Messrs. McFarlane and Crosbie recently ap-

pointed to temporary positions in this division, have been transferred to New Brunswick and are attached to the spruce budworm survey parties.

A very severe outbreak of potato beetles was reported from Manitoba and the wheat stem sawfly has appeared in large numbers in certain districts of Canada during the past season.

Doctor Swaine and Mr. Fleming left Ottawa July 4 for an inspection of the spruce and balsam conditions on the timber limits of the Abitibi Pulp and Paper Company in the vicinity of Lake Abitibi, northern Ontario. They also intend to select sites for the establishing of sample plots in that district.

Mr. A. E. Kellett, artist and chief photographer of the Entomological Branch, Ottawa, Canada, since 1913, resigned on July 31. Mr. Kellett's resignation will be regretted by all members of the staff. He plans to go to London, England, early in the fall to study at one of the well-known art schools.

Doctor A. G. Boving and Doctor F. C. Craighead left Washington on June 25 for Harrisburg, Pa., to consult with Professor J. G. Sanders, economic zoölogist, and to study the coleopterous larvæ in the State Museum. The state of Pennsylvania is publishing Doctor Craighead's large illustrated paper on cerambycid larvæ.

Mr. John J. Davis, in charge of the Japanese beetle work at Riverton, N. J., has accepted the position as head of the Department of Entomology at Purdue University, Lafayette, Ind., and will report for duty October 1. Mr. C. H. Hadley, who has been connected with the work, will succeed Mr. Davis in charge of the Japanese beetle work at Riverton, N. J

Professor T. D. A. Cockerell of the University of Colorado spent the last two weeks in June assisting S. A. Rohwer to arrange the National Collection of bees. This was a very large task to complete in so short a time, but by unusual effort the entire named collection has been arranged in one series and a small part of the unworked material identified.

The maximum flight of the European corn borer in eastern Massachusetts began June 12, which is about ten days later than in 1918 and 1919. Eggs of the insect were found in abundance on various plants June 15, and a remarkable departure from the habits of the insect in former years was observed in the deposition of many egg clusters on spinach, beets, and other cultivated plants.

Doctor J. H. McDunnough returned from his collecting trips to the Lake of Bays, Ontario, the latter part of July. Special attention was paid to the Odonata, and since his return Doctor McDunnough has been working over the material in the National Collection. As a result of his trips several new records have been established for Ontario and at least two for Canada. Officers in charge of laboratories wishing to have their Odonata identified should send in their material as soon as possible.

A reorganization of the Division of Entomology at the University of California has been announced, taking effect July 1 of this year. The personnel of the division consists of eight members and will hereafter be known as the Division of Entomology and Parasitology, with Professor W. B. Herms as newly appointed head. Professor Herms will continue his activities in the field of parasitology, particularly medical entomology and ecology, while Professor C. W. Woodworth will devote his time largely if not wholly to research. The new organization of the division embraces three groups with assistant Professor E. C. Van Dyke as chairman in supervision of activities in general entomology and taxonomy; Assistant Professor Essig, chairman in supervision of agricultural entomology, and Assistant Professor S. B. Free-

born, supervising activities in parasitology, particularly in relation to the animal industries. Doctor H. H. Severin will continue investigating *Eutettix tenella* in relation to sugar beet blight, while Messrs. E. R. de Ong and G. A. Coleman will continue their activities in their respective fields, namely University Farm School and apiculture respectively.

The following appointments have been made in the Entomological Branch, Canadian Department of Agriculture: Mr. F. P. Ide, temporary laboratory helper, Division of Systematic Entomology; Mr. H. G. Hammond, temporary seasonal assistant, Division of Field Crop and Garden Insects at Ottawa; Mr. R. S. Hawkins, Mr. A. H. MacAndrews, temporary seasonal assistants, Spruce Budworm Survey, Fredericton, N. B.; Mr. R. S. Longley, insect pests inspector, Division of Foreign Insect Pest Suppression, Wolfville, N. S.; Miss M. G. Runciman, temporary junior clerk stenographer, at Annapolis, N. S.

Announcement has been made of the following resignations from the Bureau of Entomology: Jacob Kotinsky, to enter commercial work; H K Plank to accept a position as entomologist of the new Agricultural Experiment Station, Guayaquil, Ecuador; D. F. Barnes, C B. Russell, F. S. Vidler, gipsy moth work, to enter business, and Doctor R W. Glaser, of the same force, to accept a position with the Rockefeller Institute of Medical Research; H. W. Allen, Arlington, Mass., to accept a position with the State of Mississippi; A. L. Ford, West Lafayette, Ind., to become extension entomologist for South Dakota; F. B. Herbert, Los Gatos, Calif., Ada F. Kneale, Washington, D. C.; Everett E. Wehr, Dallas, Tex., to re-enter college; T. H. Cutrer, Baton Rouge, La , to enter commercial work; Thomas H. Jones, to become state entomologist of Louisiana

The following transfers are announced in the Bureau of Entomology: John B Gill, Monticello, Fla., to Brownwood, Tex ; Samuel Blum, Columbia, S. C , to West Lafayette, Ind.; Max Kisliuk, Jr., Wilmington, N. C., to Federal Horticultural Board, El Paso, Tex ; J. G. Hester, Kingsville, Tex., to Federal Horticultural Board, El Paso, Tex.; R. A. Vickery, San Antonio, Tex., and A. H. Beyer, Wichita, Kan., to corn borer work, Boston, Mass.; C. H. Gable, Tempe, Ariz., in charge of station, San Antonio, Tex.; H. P. Wood, Dallas, Tex , to Arlington, Mass.; J. N. Tenhet, Quincy, Fla., to Clarksville, Tenn.; L. Z. Taylor, from boll weevil force to the Insecticide and Fungicide Board; W. M. Davidson, Alhambra, Calif., to Vienna, Va.; F. J. Brinley, Greeley, Colo., to Riverton, N. J.; Mrs. M. L. Gardner, to Bureau of Biological Survey; George N. Wolcott, Bureau of Plant Industry to Bureau of Entomology; C. W. Stockwell, Melrose Highlands, Mass., to Riverton, N. J., in charge of plant quarantine inspection in connection with the Japanese beetle.

Appointments to the Bureau of Entomology are announced as follows: H. E. Thompson, Riverton, N. J.; Miss Julia E. Edmonson, insect delineator, Washington; Miss Lorena Stratton, Medford, Ore.; W. J. Ahearn, M. H. Feeney, G. J. Galvin, R. W. Kennedy, J. F. Keough, P. Meagher, G. A. Miller, A. C. Ward, W. G. Bradley, J. A. Priest, G. E. Abbott, W. W. Bancroft and S. E. May, gipsy moth work; T. M. Cannon, W. B. Clark, C. O. Larrabee, Boston, Mass.; R. J. Chambers, Arlington, Mass.; Miss Josephine Reed, Wichita, Kans.; Webb B. Williams, boll weevil force; Robert Fouts, Carlisle, Pa.; W. F. Runyen, Riverton, N. J.; cotton-boll weevil, Tallulah, La., F. R. Bibby, M. R. Smith, J. C. Woolley, G. W. Alexander, S. N. Boyd, A. J. Chapman, Joseph Crister, B. M. Deavenport, Clyde Dunn, J. A. Harris, R. T. Hobson, T. H. Holland, J. W. Hollandsworth, E. E. Holley, J. A. Humphries, A. J. Mattox, A. G. McCarty, L. G. Plyer, Wm. D. Reed, Arthur Shaver, Wm. R. Smith, W. A. Stevenson, Adolph Thomas, W. B. Vinzant, R. L. White, V. V. Wil-

liams; Madison, Fla., W. W. Alexander, Paul Calhoun; tobacco insects, Clarksville; Tenn., L. N. Judah, J. T. Lewis, Jr., Scott C. Lion, M. L. MacQueen, T. P. Weakley, sugar cane insects, New Orleans, La., W. E. Haley, Brownsville, Tex., L. R. T. Cowen; miscellaneous insects, Mound La., Charles G. Van Dine.

Doctor R. J. Tillyard, in charge of biology, Cawthron Institute of Scientific Research, Nelson, New Zealand, visited Boston, Philadelphia, Washington, New Haven, Conn., and Amherst, Mass., the latter part of August on his trip around the world. Doctor Tillyard is traveling in the interests of his government and of The Cawthron Institute, and is especially interested in acquiring information about equipment, books and insect pests. The woolly aphid of the apple is one of the important pests in New Zealand. From the Eastern States, Doctor Tillyard will visit British Columbia and return home via Honolulu where he expects to stop for a month.

The following appointments and changes in the Division of Entomology, North Carolina State Department of Agriculture, at Raleigh, are announced: Mr. C. S. Brimley, formerly zoölogical collector and dealer, and author of many papers on zoölogical and entomological subjects, is engaged for insect survey work and other projects. Mr. V. R. Haber, from Department of Entomology, University of Minnesota, is to take up household insects and to assist in other projects. Mr. W. B. Mabee, from the Montana Agricultural College, will take up extension entomology in place of M. R. Smith, resigned, and Mr. T. B. Mitchell, from Massachusetts Agricultural College, will take up inspection and field work in place of Mr. J. E. Eckert, resigned. The staff of the Division is now: F. Sherman, chief in entomology; R. W. Leiby, assistant entomologist, investigations; C. S. Brimley, investigations; V. R. Haber, investigations; T. B. Mitchell, inspections and field work; W. B. Mabee, extension; C. L. Sams, beekeeping extension, in co-operation with Bureau of Entomology and Miss Ellen Hinsdale, clerk.

THIRTY-THIRD ANNUAL MEETING OF THE AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

The thirty-third annual meeting of the American Association of Economic Entomologists will be held at the University of Chicago, December 29 to 31, 1920. Notices have already been sent to the members, requesting titles for papers. These must be in the hands of the secretary by November 13, in order to appear on the program.

Applications for membership may be secured from the secretary or from the chairman of the committee on membership. They should be filled out and filed with the chairman of the committee prior to the time of the meeting.

The Chicago meeting will be an important one and promises to be largely attended. In addition to the meetings of the sections on apiculture and horticultural inspection, it is expected that a joint session will be held with the American Phytopathological Society.

A. F. Burgess, *Secretary*

Mailed October 30, 1920

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Proceedings of the Fifth Annual Meeting of the Pacific Slope Branch of the American Association of Economic Entomologists

The fifth annual meeting of the Pacific Slope Branch of the American Association of Economic Entomologists was held in Room 211, Science Hall, University of Washington, Seattle, Wash., June 17-18, 1920.

The first meeting was called to order at 9.30 o'clock a. m., June 17, by Prof. A. L. Melander at the request of Chairman E. M. Ehrhorn, who was unable to be present. Professor Melander was then elected chairman for the meetings and Dr. Edwin C. VanDyke as secretary in the absence of E. O. Essig.

A brief business session followed in the morning and in the afternoon and on the following day the regular papers were presented and discussed. Officers were elected on the last day of the session.

Although the number of members present was small there were many other interested entomologists present and the meetings were successful in every respect. The meetings afforded an opportunity to take up at first hand many of the very interesting problems of the great Northwest and will materially strengthen the Association there.

PART I. BUSINESS SESSION

The business meeting was called to order by Chairman A. L. Melander at 9.30 o'clock, June 17, 1920. The following were present:

*F. E. Bailey, Prosser, Wash.
Alfred C. Burrill, Forest Grove, Ore.
Joseph DaVise, Yakima, Wash.
*Chas. W. Hauck, Yakima, Wash.
*J. Frances Killeen, San Francisco, Cal.
Trevor Kincaid, Seattle, Wash.
F. H. Lathrop, Corvallis, Ore.
A. L. Melander, Pullman, Wash.
E. J. Newcomer, Yakima, Wash.
*Max M. Reeher, Forest Grove, Ore.
*G. P. Rixford, San Francisco, Cal.
*Chas. L. Robinson, Yakima, Wash.
L. P. Rockwood, Forest Grove, Ore.
Anthony Spuler, Pullman, Wash.
*E. P. VanDuzee, San Francisco, Cal.
Edwin C. VanDyke, Berkeley, Cal.
R. K. Vickery, Palo Alto, Cal.
W. D. Whitcomb, Yakima, Wash.
*E. G. Wood, Walla Walla, Wash.

* Visitors.

The following committees were then named by the chairman:

Editorial: Edwin C. VanDyke, Chairman, Anthony Spuler, R. K. Vickery.

Nominating: Edwin C. VanDyke, Chairman, Anthony Spuler, R. K. Vickery.

Membership: E. J. Newcomer, three years, Chairman.

The report of the secretary-treasurer was then presented and was duly audited.

REPORT OF THE SECRETARY-TREASURER

Financial Statement 1919–20

1919				
Feb.	24.	On hand		$24.60
June	30.	Express on proceedings	$ .62	
1920				
March	29.	Paid for stamped envelopes	1.14	
May	2.	Paid for stamped envelopes	2.15	
	15.	Paid Affiliation fee to Am. Assn. Adv. Science	5.00	
			$8.91	$24.60

June 7, 1920.	Amount on hand	$15.69
	Refund from Am. Assn. Econ. Ent. *due*	8 91

Afternoon Session, June 18, 1920

At the end of the regular meeting the following committees were called upon for reports:

Nominating Committee

The following were nominated for office during the ensuing year:

For Chairman, E. O. Essig, Berkeley, Cal.

For Secretary-Treasurer, A. L. Lovett, Corvallis, Ore.

These were duly voted upon and elected.

Membership Committee

The membership committee made a recommendation that the Membership Committee of the parent Association be requested to revise the list of Pacific Slope members in order to elevate deserving associate members to active standing. This recommendation was received by those present and the chairman, Mr. E. J. Newcomer, was asked to take the matter up directly with the proper parties in the East.

Editorial Committee

This committee reported a revision of the papers submitted with the recommendation that because of very special interests certain

papers be returned to the authors in order to reduce as far as possible the proceedings to those papers of real interest to all of the members of the Association. The Secretary was asked to return the papers thus set aside.

CHAIRMAN A. L. MELANDER: This concludes the convention. We stand adjourned to meet at San Francisco, Cal., next year.

Meeting adjourned.

E. C. VANDYKE, *Secretary pro tem.*

PART II. PAPERS AND DISCUSSIONS

Morning Session, June 17, 1920, 10.30 p. m.

CHAIRMAN A. L. MELANDER: The regular papers for presentation and discussion will now be taken up. The first on the program is on "The Winterkilling of Codling Moth Larvæ."

WINTERKILLING OF CODLING MOTH LARVÆ[1]

By E. J. NEWCOMER, *U. S. Bureau of Entomology, Yakima, Wash.*

It is a common experience in the spring to find "winter-killed" codling moth larvæ. The writer, however, does not remember seeing any figures on the percentage of mortality resulting from different degrees of cold. Accurate figures could be secured only under controlled temperature conditions, but an opportunity has occurred recently of obtaining some interesting figures of mortality resulting from natural conditions.

In Washington State, temperatures far below the normal were experienced during December, 1919, ranging in the Yakima and Walla Walla valleys from −14° to −36° F. At Yakima, on December 9 and 10, there was a snowstorm with some wind, almost of the character of a blizzard, the temperature for the two days ranging between 7° and 16° F. The storm cleared away on the 11th, the minimum temperature being 0°. For the succeeding four days, the temperatures were as follows:[2]

December	*12*	*13*	*14*	*15*
Maximum	1	1	4	12
Minimum	−22	−24	−18	−9

During this period there were from 4 to 18 inches of snow on the ground. After December 15, the weather warmed up gradually, and

[1] Presented with permission of the Secretary of Agriculture.

[2] Figures taken from Climatological Data, U. S. Weather Bureau.

for five or six days after the 20th, the temperature remained above freezing.

Examinations of larvæ were made during the period from December 23 to February 28. It was found that wherever the minimum temperature had been lower than −25°, all larvæ, with no protection other than bark or burlap bands, were killed. At the Bureau of Entomology Laboratory in Yakima, the minimum temperature was −25°, and several thousand larvæ wintering in pupation sticks all succumbed. In orchards within two or three miles of the laboratory, and on higher ground, where the minimum temperatures ranged from −20° to −25°, 80–90 per cent of the larvæ were killed. On still higher ground, with minimum temperatures of −15° to −20°, the mortality was approximately 70 per cent. Reports from the Wenatchee Valley, where the lowest temperature recorded was −20°, placed the mortality at from 75–80 per cent. There was no opportunity of examining larvæ in situations where the minimum temperature was higher than −14°. In all cases, these figures apply to the larvæ wintering above the snow line.

As the ground was frozen at the time of the earlier examinations, it was impossible to ascertain the condition of the large number of larvæ which winter under the surface of the soil. In February, however, examinations were made of the larvæ which spun their cocoons about the tree trunks an inch or two beneath the soil surface, where they were undoubtedly covered with snow during the cold weather. On February 28, a banded orchard was examined near Zillah, Wash., where the temperature had dropped to −24°, according to an unofficial record. The land was somewhat rolling, and it is probable that the drifting snow had accumulated in varying depths about different trees, as there was a marked variation in the condition of the larvæ found on the various trees. The mortality ranged from 100 per cent on some trees to as low as 66 per cent on others, with an average for 280 larvæ counted, of 76 per cent. One interesting fact noted was that frequently, on tearing away the burlap band, one or two live larvæ would be found in the midst of a number of dead ones. It seems impossible, in these cases, that the live larvæ had any more protection than the others. They must simply have had more vitality.

All these records were obtained in the arid section of Washington. It would be interesting to know whether temperatures such as were experienced in this section would produce a similar mortality in more humid regions, such as the coastal sections of Washington and Oregon, or parts of the eastern United States.

Chairman A. L. Melander: The next paper is entitled, "Winterkilling of the San José Scale."

WINTERKILLING OF THE SAN JOSÉ SCALE

By Anthony Spuler, *Washington State College*

Since early in the spring there has been considerable evidence to lead the fruit grower to believe that the San José Scale had been killed in large numbers during the past winter. The usual method of scraping the bark of badly infested trees with a knife showed that the insects were not juicy as commonly found at this time, but that they were dry and came off readily.

In order to determine to what extent the scale had been killed, a thorough examination of their overwintering condition was made. Early in March the district horticulture inspectors sent in infested branches from a number of orchards in each of the fruit-growing sections of the state. This was followed a little later by a personal investigation in the field in which all of the fruit-growing sections were visited. Samples were cut from healthy trees in a number of orchards within a district. Every effort was made to secure material that was typical for the various localities visited. The material secured in this way was carefully examined. Thousands of individual insects were dissected off under a binocular and their condition noted. It was possible in this way to learn the per cent of San José Scale still alive. Following are the results obtained:

Locality	Total Counted	Dead	Alive	Per cent Alive
Clarkston	10,144	9,595	549	5.4
Walla Walla	12,816	12,388	428	3.2
Prosser	2,545	2,545	0	0
Yakima	8,595	8,526	72	1.5
White Salmon	2,093	1,729	364	17.8
Wenatchee	5,409	5,309	100	1.8
Spokane	2,485	2,013	472	19.2

In contrast to the foregoing is the average per cent of winterkill of the San José Scale for the past ten years, not including the winter of 1919–20 for the following localities: Clarkston, 19 per cent; Walla Walla, 24 per cent; Yakima, 32 per cent and Wenatchee, 40 per cent.

The high percentage of winterkill of the scale might be explained in two ways. In the first place the winter started rather early. In October the temperature in the fruit-growing sections dropped as low as 12 to 14 degrees Fahrenheit. This was in all probability before the scale had gone into hibernation and before they were in a condition to

withstand the severe cold. In the second place the weather was unusually severe. Weather records for the past twenty years fail to show a similar occurrence. The minimum temperature records for the various sections are as follows: Clarkston, −26; Walla Walla, −36; Yakima, −24; Prosser, −30; Wenatchee, −16 and Spokane, −15.

Chairman A. L. Melander: Mr. R. K. Vickery will now give a paper, "Petroleum Insecticides."

PETROLEUM INSECTICIDES

By Robert K. Vickery, *Assistant Entomologist, California Spray-Chemical Co.*

The government lately published a warning foretelling the rapid depletion of our petroleum resources. We are now using millions of gallons of oil to kill insects. A shortage will inevitably multiply the price many times and, if I may, I would like to discuss briefly the subject of petroleum insecticides and also incidentally record a few observations and experiments.

In the past it has been economical to use the petroleum products of commerce for insecticides. Efficient sprays were made from kerosene, crude oil, lubricants, and the by-product distillates. The everyday household and industrial demand for these oils made them available in every market. Certain products, suitable for insecticides, were relatively cheap. Today these oils are sometimes hard to obtain and the price has trebled within the last five years. The reason is not hard to find. The refiners now find it profitable to make cracked gasoline and lubricants out of these cheaper oils.

With such excellent insecticides at hand there has been little incentive to study the toxicology of petroleum to insects. For many years it was presumed that these oils suffocated the insects by mechanically closing the spiracles. Shafer and others have shown that petroleum is a true chemical poison. This is simply demonstrated by the rapid killing of an insect confined in an atmosphere saturated with the gases given off by kerosene. Shafer also showed that for all practical purposes it was impossible to smother an insect. With the idea of suffocation in mind it was easy to select an oil purely by the physical properties, specific gravity, viscosity, etc., used to distinguish oils industrially. Toxicology is fundamentally a chemical study and little is gained by testing the insecticidal values of different oils distinguished from one another by their physical properties. We must go deeper and study the oils as chemicals if we are to improve our present knowledge.

No one knows what compounds in petroleum are actually toxic to insects. Chemically, petroleum is a complex solution of hundreds of compounds, and oils from different fields are composed of different proportions and arrangements of these. The present knowledge of the chemistry of petroleum is very limited. Certain structural series have been identified, but practically no compounds have been isolated or synthesized. At one time I was able to get a pure sample of Pentane. It had the physical properties of gasoline and its vapor proved equally toxic to the silkworm.

There is good evidence to show that not all petroleum products are toxic to insects. Kerosene, particularly in California, sometimes fails unaccountably to kill scale insects. Freeborn and Atsatt report that oil refined for medicinal purposes is not toxic to mosquito larvæ. The writer once tried to use a residual oil in mosquito work that failed to control when applied to the water in the usual thin film. Combining 10 per cent of kerosene or crude distillate restored its toxic properties.

It is possible that research might reveal that certain compounds in petroleum are particularly valuable insecticides. Economic demand might make it profitable to prepare these synthetically. To carry out such an investigation a closer study should be made of the physiology of petroleum as an insect poison. Shafer has made some progress along this line, using chemical methods, and has offered the suggestion that insects are killed with petroleum by an upsetting of the balance between the oxidizing and reducing enzymes in the body fluid.

At one time I took up this problem using histologic methods. The larvæ of the silkworm and the California oak moth, *Phryganidia californica,* proved to be the most satisfactory material on account of the ease with which the different organs could be dissected out. Two series of slides were made of each of these two species. In one series the larvæ were all killed by being exposed to the vapors of gasoline. The other series was made as a control. Both series received identical treatment. Some larvæ were treated by the hot water killing method and others by a modified fluid of Carnoy. Some of the larvæ of both series were not dissected but, hardened, cleared and mounted in paraffine so that complete serial sections could be prepared of the entire insect. Other slides were made of the various organs. These slides were stained with iron hæmotoxylin and counterstained to bring out the different tissues. It was almost impossible to find any difference between the gasoline killed and control material. The only consistent difference was in the ductless glands, the œnocytes, which showed great activity in the gasoline killed insects. This activity was shown by large drops of fluid around the inner periphery of the cell. Glazer found that the œnocytes secrete an oxidizing enzyme. Located, as

they are, enmeshed in the trachæ close to the spiracles, their function is no doubt respiratory. Moore has pointed out that the spiracles are the weakest link in the insect's armor against contact insecticide. He has also shown that the heavy vapors of petroleum and the other volatile contact insecticides are the most efficient. These heavy gases will condense on the walls of the trachæ. There may be some relation between these various observations but more work must be carried out before conclusions can be drawn.

Moore's work on the physical properties of contact insecticides is a valuable contribution to our knowledge of petroleum insecticides. His definition of wetting and spreading will eliminate confusion.

A knowledge of the chemistry of petroleum may make it possible to find compounds fatal to insects and not injurious to plants. Unfortunately oils penetrate plant tissues about as easily as they penetrate into the insect. The history of petroleum sprays has been a development of methods to protect the plant from the injury caused by the commercial oils. The emulsion has made it possible to dilute the oil with water. The early mechanical mixtures gave trouble. The soap emulsions have proved satisfactory where soft water is available. The invention of the miscible oil has made it possible to commercialize the soap emulsion. Unfortunately the miscible oil formula is not adapted to the heavy oils. We have found in California that a natural crude oil of about 24° Bé is the most efficient spray to control diaspine scales. This oil, coming direct from the wells, contains volatile and heavy fractions. The heavy fractions are no doubt valuable in that they control the rate of evaporation of the lighter and more toxic fractions. A blend of distillate and lubricating oil gives the same result. The high price of cresol soap has made the cost of miscible oils rather high compared to the home-made emulsion, that is if the cost is compared on the basis of petroleum content. The latest improvement has been along the line of colloidal emulsions. These can be made with any oil and being chemically inert will mix with hard water, lime sulphur solution, arsenates, etc. By using a mixture of different colloids as an emulsifier good spread and penetration can be obtained.

These emulsions have all been developed with the idea of protecting the plant from oil injury. Professor George P. Gray made a fundamental advance when he discovered that the unsaturated petroleum compounds were, as a class, far more injurious to plants than the saturated series.

Modern synthetic chemistry is making available hundreds of thousands of compounds not only derived from petroleum but from other sources. Some of these are undoubtedly toxic to insects. The scarcity of petroleum with its resulting high cost may make it profitable to hunt

out these compounds. We are still a long way from the ideal contact insecticide. This should be an active insect poison and harmless to the most tender foliage. It should have good keeping qualities and be usable either as a liquid or as a dust.

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CHAIRMAN A. L. MELANDER: We shall now take the regular noon recess and adjourn to meet again at 2 o'clock p. m.

Meeting adjourned at 12 m.

Afternoon Session, June 17, 1920, 2 p. m.

CHAIRMAN A. L. MELANDER: A very interesting communication to Secretary E. O. Essig, sent to me, will, I am sure, prove of interest to all present and will be read by the Secretary:

Gainesville, Fla.,
May 31, 1920.

MR. A. L. MELANDER,
Agricultural Experiment Station,
Pullman, Wash.

Dear Mr. Melander:

I have delayed in reply to your kind favor of April 30, written at the request of Secretary Essig of the Pacific Slope Branch of our Association, as I had hoped that circumstances would so shape themselves that I might be able to attend.

However, it is now certain that I cannot be in attendance at that time, hence will comply with your request by sending a short letter which, if thought suitable, can be read at the meeting. This letter I have addressed to Mr. E. O. Essig, as Secretary, and am enclosing it herewith. You can transmit it at your convenience.

Thanking you very much for your invitation, which I regret I am not able to accept, I beg to remain

Very truly yours,

WILMON NEWELL,
President.

May 31, 1920.

MR. E. O. ESSIG, SECRETARY,
Pacific Slope Branch,
American Association of Economic Entomologists,
Seattle, Wash.

Dear Sir:

The writer has delayed reply to Mr. Melander's letter of April 30 in the rather forlorn hope that circumstances would shape themselves so that he could attend the session of the Pacific Slope Branch of our Association. However, developments have been such that it will not be possible for me to be in attendance, and I take this method of extending my greetings to your members and wishing for you a most pleasant and profitable meeting.

It seems to me the time has arrived for the economic entomologists to be more aggressive and to place the value of their profession more prominently before the public. Within the past two years there have been rather numerous complaints to the effect that entomologists are not as well paid for their services as the value of their work seems to merit. This must be conceded, but at the same time it must also be conceded that the economic entomologist has not made his services indispensable in the way that members of many other professions have. When it is realized that the entomologist is as necessary to agricultural production as is the chemist or the implement manufacturer this state of affairs will be remedied.

The economic entomologist has his future and that of his profession in his own hands. If he shows that he is, collectively, able to inaugurate, execute and complete entomological projects of magnitude which either prevent enormous losses from injurious insects or make the recurrence of such losses impossible he will come to be considered as a necessity, rather than as a convenience.

With few exceptions entomologists have thus far confined their efforts to investigating the habits of insects and in devising or recommending palliative methods. By "palliative" methods we mean such measures as merely reduce the loss without eliminating it or preventing its recurrence. Spraying, using poisoned baits and employing cultural methods all fall within this category. The employment of insect parasites or fungous diseases for control of a pest may be considered in the same light: they may reduce the losses, but they do not remove the source of the loss.

The time has come when entomologists should make ready for really big undertakings, such as the eradication of injurious species or prevention of the establishment of injurious forms new to our country.

We have only to glance over past history to see the opportunities along this line which have presented themselves, only to be neglected. Take the case of the gypsy moth, for example. Twice in the history of this insect in America its eradication has been within reach at moderate cost and with a minimum of effort. The expenditures out of public funds in fighting this pest have, to the present time, aggregated

more than $17,000,000 and the losses due to its ravages have exceeded this figure many fold. Its eradication is yet possible for the methods being used to prevent its spread are really eradicative in nature and have only to be employed upon a sufficiently extensive scale, with sufficient speed, to annihilate this pest in our country.

In the southeastern United States the cattle tick has already been eradicated from approximately 460,000 square miles, an area equivalent to the combined territory embraced in the states of Kentucky, Virginia, Tennessee, North and South Carolina, Georgia, Alabama, Mississippi and Louisiana. The year 1924 will probably see its eradication completed. One is tempted to ask why this task, of tremendous economic moment to the South, was not taken up and executed by entomologists, instead of by veterinarians?

The Federal Horticultural Board is now engaged, in the states of Texas and Louisiana, in a hand-to-hand struggle with the pink bollworm. Already approximately $1,400,000 of federal funds have been expended on the work of eradication and it is still far from complete.

In Florida a plant disease, citrus canker, has been eradicated during the past five years, at a cost of $1,342,000. Large as this figure appears, its intelligent expenditure has nevertheless saved from destruction the citrus industry of Florida, which represents an investment of $175,000,000 and which brought to the growers the past season not less than $43,000,000. This was not an entomological project in any sense of the word, though it happens that the work was under the direction of one who is an entomologist rather than a pathologist. It is mentioned here as an illustration of what can be accomplished and as an example which should be duplicated in the entomological field with as little delay as possible.

There are today under way in the United States no less than six campaigns to eradicate plant diseases. The efforts of the Federal Horticultural Board to eradicate the pink bollworm, of Florida to eradicate the banana root-borer, and of Mississippi and Florida to eradicate the sweet potato weevil, seem to make up the sum total of efforts along this line in the entomological field.

Is it not time that we were "up and doing"?

Very sincerely yours,

WILMON NEWELL,
President.

PRESIDENT A. L. MELANDER: The next paper by W. Dwight Pierce, on "Commercial Entomology and the Service It Can Render to Organized Agriculture," will be read by Secretary VanDyke.

COMMERCIAL ENTOMOLOGY AND THE SERVICE IT CAN RENDER TO ORGANIZED AGRICULTURE

By W. DWIGHT PIERCE, *Managing Director, Biological Department, The Mineral, Metal and By-Products Co., Denver, Col.*

Commercial entomology is such a new phase of economic entomology that it behooves us to give considerable attention to its possibilities, its field, the type of service it can render, and the trend of the times which has made this new branch of our science possible. We are living in a period of seething change and readjustment! Effort is being cast into new channels. Old methods are being ruthlessly thrown aside.

Two conflicting elements are battling throughout the world: the one is the demand for greater and greater efficiency in production, the other is the demand for greater leisure and less expenditure of physical effort. These two demands can be harmonized by coöperation, but strife may cost the loss of both.

The minds of men are tending toward the aggrandizing thoughts of special interest—selfish, personal interest. Everywhere we see those with like interests banding themselves together in one or another form of organization, in order to protect their own interests, and to get for themselves as much of an advantage as they can obtain. Such a tendency, unrestrained by the recognition of the rights of others, is dangerous to our commonwealth.

But the tendency to organize is with us, and we ourselves contribute our part to it. We can get nowhere by bewailing prevailing tendency. The world moves on and crushes those who delay its progress. We must therefore look on these matters in a different light. If the tendency is world-wide, there must be a basic, underlying reason for it, and hence there must be an element of truth, right, or justice in it. Let us seek this kernel of good and hold it up before the world, and say: "This is what all these great world movements mean, so let us profit by this knowledge, and turn the path of movement so that civilization will be improved."

I can see both good and bad in the overwhelming desire of every special group to organize, and I believe that we entomologists must recognize these facts and adjust our efforts to the new trend of affairs. We are concerned today with agricultural organization. Surely it has many advantages, but it can likewise become a weapon of harm.

Recent Tendency in Agriculture

In the last decade we have seen the organization of the producers of agricultural products develop with increasing momentum, until now the producers of many of our most important crops, and of many crops formerly little used, are well and efficiently organized. Now if the purpose of these growers' associations is merely to gain a control of the price of the commodity and to maintain its prices at a high level, or is designed to enable the growers to gain preferential special class legislation, there is an element of grave danger in them. Let us hope that the time will never come when every group of individuals is centering its efforts around getting all of the special class legislation it can get, and forgetting all about the rights of the citizens at large. Then there would be an end to American patriotism.

Let us picture a model growers' association, with its purposes and ideals, and the service it can render America. It is to such an organi-

zation that we as entomologists can render service of a very noteworthy nature. This association is composed of American patriots who put America first, their own beloved state next, and harmonize their own personal welfare with the welfare of their fellow citizens. These patriots will stand up boldly for the suppression of special privilege to any class, whether it be capital, or labor, producer, or non-producer; and will stand out just as firmly against discrimination aimed at any class. By coöperation they will solve their labor problems; will improve the grades and marketing condition of their products; open up and improve their markets; obtain fair rates of transportation and storage; prepare such legislation as will establish honesty in the industry and insure producer, handler, and consumer a fair deal; will create a greater demand and more fields of usefulness for their product; and will engage experts to study the special problems of their crops.

In the old-style agriculture every producer was a unit by himself, and he had to deal with men of business acumen who were better organized than himself. Now, when he is properly organized he has business agents who attend to the packing, marketing, transporting and sale of his products, and he becomes a member of a group dealing in a business way with other organized groups of people.

We are still in the preliminary stages of organized agriculture. The cotton growers of the South, for instance, have just completed their business organization, but so far they have as objectives, principally, those problems which point to improvement of marketing conditions. Later we can expect them to expand their ideals, until they themselves will employ expert advice in solving some of the tremendous problems of production which face them. As an example of associations which recognize the importance of technical advice, we may quote the Hawaiian Sugar Planters' Association, which has a fully equipped experiment station, and sends high priced experts to all parts of the world in quest of information, or parasites, or improved varieties. Here on the Pacific Coast we probably have more organizations, and more efficient ones at that, than anywhere else in the world at present.

The very fact that growers are organizing is a recognition of the fact that there is a community of interests, although it does not mean that the growers recognize how extensive is their community of interests, nor how many people are involved in these interests. Let us take a lesson from the newly formed American Cotton Association. This association recognizes a community of interest between growers, ginners, oil mill men, spinners, bankers and merchants, and all of the many special interests which handle cotton, and its membership takes care of these various interests. Such a breadth of vision is refreshing, for it holds promise of a coöperative uplift movement for a vast section

of our nation. It means that everyone who derives his income directly or indirectly from the production of cotton is a potential contributing member of this association, and our vision shows us a time in the near future when this cotton empire will be pushing forward on a sound financial and economic wave of prosperity. At the same time we can see how such a powerful organization in the hands of men of narrow vision can merely become a weapon of offense and even danger.

My point is that the grower must recognize that there are those, who do not produce his crop, who have as vital an interest in it as himself, and he must, in justice to himself and the other fellow, harmonize his organization and its activities with the interests of other people.

Next, the growers must recognize the necessity of protection of crops from injury, and that this protection must extend beyond their own membership, to everyone who produces their special crop. Furthermore, it often happens that this protection must extend to other crops entirely, and joint action with other associations is called for.

The Need of Concert of Action against Pests

Pests are no respecters of person. They are individualists, working for private gain. They do not operate by coöperation, except in the case of the ants, and consequently in the absence of leadership, their attack is often unexpected, irregular, and baffling. When we fight insect pests and diseases as individuals, we pit guerrilla warfare against guerilla warfare, and we have nothing but a continuous series of reprisals. When we fight them through organization, we pit scientific, organized warfare against aimless banditry. The result is obviously victory, although the struggle may be long and arduous.

Insects and disease create economic waste. They live as parasites on the results of our labors. They reduce our profits, they increase our expenses, they make our labor more arduous. In the wake of a great insect scourge there lie devastated fields, ruined prospects, indebtedness, consternation of labor. Business houses which have loaned on these devastated crops become financially embarrassed, and often fail; mortgages pile up on the farm, and real estate values depreciate. The ignorant labor flee before the wrath of heaven, and a once prosperous section grovels and bemoans its fate. This is not an overdrawn picture. It has happened over and over again in this country. One insect pest alone, the cotton boll weevil, extracts an annual toll of hundreds of millions of dollars in potential crops, and has cost this country over a billion dollars. It alone has scattered panic and poverty, debt and fear.

There is but one way to meet a great insect pest, and that is by organized coöperative effort. Private action against pests is of little avail, for practically any insect or disease can bridge the gaps and

barriers that separate the fields of the careful man from the fields of the careless man, and the careful man must do his work all over. Too long have we contented ourselves with the opiate of satisfaction that we have done all that we could do when we have treated our own fields, and that what happened thereafter was an act of Providence and beyond our power.

No insect or disease is beyond the power of mankind to combat if we go at it scientifically and with perfect coöperation. In fact we must do so in the future, or yield superiority in agriculture to the hitherto wild parts of the world where pioneers with vision are beginning to break the ground for competitive agriculture.

Don't let that chimera of tremendous cost stand in the road of more efficient production. Whenever someone has suggested, in the past, a comprehensive fight against some pest, the scientific world has held up its hands in holy awe, and monotonously cried, "It can't be done, it can't be done!" Are we such grovelling simpletons that we are afraid to tackle our problems efficiently, because we are afraid to mention huge sums of money? Who is there, that has the temerity to suggest that we can successfully fight a pest robbing us of one hundred million dollars every year, by appropriating a paltry hundred thousand dollars? Why should we waste our money by throwing it in driblets at an all-consuming pest? Can a regiment hold back an advancing army?

Gentlemen, I will venture to say that the time is not far distant when organized agriculture will view its economic problems with broad vision and will fight all insects and disease from a business standpoint. The business man does not view huge figures with alarm, when the evidence, the plans and the expected results are placed before him in a businesslike manner. It is therefore the place of the entomologist of the future to secure his facts, and record them after the manner of business, and to plan to meet insect attack in an effective and comprehensive manner.

The Function of Government Contrasted with the Function of Commercial Enterprises

The American people, and even our own membership, have fallen into the error of thinking that all great insect investigations and enterprises are functions of government, and not of private initiative. This mistake has greatly retarded many phases of agricultural progress, because it has led the individual to think that the Government would do his work for him. It is the province of the Government to investigate great problems and to give advice to all citizens on matters of a technical nature, and demonstrate new methods. When the entire

nation or a large section is threatened by pests or disease it is the function of the Government to render adequate protection to those sections unaffected. It is because of such operations that many of us have come to expect the Government to take charge of all of our pest problems.

But we would not, any of us, want to see the Government take over our fields and houses and operate them. Inasmuch as we hold that the question of production is a private affair, so also, except in unusual cases, is the question of stimulating, increasing or protecting production, a private affair. We must consider that control of pests which are widespread is no longer a function of government, but a function of private enterprise, in which the Government may assume the rôle of friendly adviser. It is not the function of government to market our crops, but we organize our marketing associations and the Government supplies us often with expert advice.

There is a distinct difference between advising and administering on a project.

Organized Agriculture Needs Organized Assistance

The farmers and growers have organized for mutual benefit. They view their problems in common and find that they as a body will be greatly benefited by a concerted attack on some devastating pest. They need scientific assistance to actually conduct the work of control, and they accordingly go about it in a businesslike manner, and ask a recognized company of experts to estimate costs and outline the methods of operation. Then by mutual assessment the cost is prorated among those who will primarily benefit, and the contract is let.

To proceed in this manner would mean efficient and effective action, and I have no doubt that such procedure will be the dominant method within a very few years.

The Advent of Commercial Entomology and What It Offers

For several years we have witnessed the desertion of official positions by men entering the commercial field. Last year the movement became very pronounced, and now we find quite a number of men in the field of pure commercial and professional entomology.

Let us canvass the field of this new profession and see what it has to offer, and how it can be of special service to organized agriculture, as well as to the individual grower. The commercial entomologist is a business man with a technical training. He has his office, and his assistants, and keeps a well-arranged library, and a file of general information on insect pests. The client seeks him out and states his problem, just as he would to the engineer. The entomologist then

gives his advice for which he charges a fee, or he undertakes to make an examination or inspection for a definite fee. Upon completion of his inspection, the client may ask for advice as to the best method of procedure and the cost, and may then decide to let the contract to the entomologist to do the work. He will in the majority of cases conclude that the professional entomologist can secure the materials and administer them more efficiently and cheaply than he himself can do.

This, then, is a sketch of what the commercial entomologist can do for the individual client. When we come to consider the large scale operations for an organization of growers, a community, state or government, we then find it absolutely essential that a business organization plan and execute the entire job. What are these large scale operations? They may be drainage propositions against mosquitoes, or horseflies, or wireworms; they may be eradication projects against insect-harboring weeds; or great wholesale fumigation of all the trees in a community; the introduction of foreign parasites; the spraying of vegetation, or treatment of the soil; or they may contemplate a variety of activities, all aimed at a comprehensive large scale eradication or control of a pest.

The commercial entomologist will go still farther, and will develop new insecticides and new apparatus for applying the same, and will in everywise devote his attention to making entomological service efficient.

Service Is the Only Reason for the Existence of Entomology

We will grant that in the early days of entomology, it was only a hobby of a few men who liked to study insects. But when we get down to the bottom of things, in this age of efficiency, we must agree that the only valid reason for the existence of any profession is the service it can render humanity. We who have been in entomology a decade or more have been frequently challenged by outsiders to show of what value our science is to mankind. We have stayed by our science because we believe that it has a distinct and great service to render, although many of us have felt that we were falling far short of our potentiality. It is only as we look at the damage insects do, or the products they produce, and study the many economic aspects of the question that we can gain the proper conception of our own sphere of activity.

We can proudly hold up our heads and tell the world that the entomologists hold the keys to the doors which will close out the depredators and thieves of agriculture; that we are equipped to quench the losses annually experienced by our animals and our crops. We must

show the man who produces that we are as good business men as he, that we understand his problems, and that we can help him make more money.

CHAIRMAN A. L. MELANDER: At this time I shall present a paper entitled: "An Index Number for Rating Codling Moth Treatments."

AN INDEX NUMBER FOR RATING CODLING MOTH TREATMENTS

By A. L. MELANDER, *Pullman, Wash.*

Fruit growers and entomologists have long felt the need of more exact methods of comparing the results of spraying than laboriously to sort over thousands of apples at harvest time and announce results in percentage of worminess. To gain accuracy it has been the custom to give a uniform treatment to a block of many trees and then to obtain counts from the central trees of the block. Even so, the central trees do not always produce the same percentage of worminess, for no matter how large a tract is treated individual trees will vary in the codling moth population they support. When it comes to comparing the value of different brands of similar sprays all used stronger than the minimum lethal dosage, when comparisons are to be made of differing methods of applications, when comparisons are to be made under conditions of varying infestation, or with trees of various ages, or in widely separated localities, the method of mass spraying and subsequent examination of selected trees for worminess has proved laborious, costly, inadequate, crude, and even misleading.

The western fruit grower is much concerned with "stings" on his fruit,—not the curculio stings of the East, but the spots resulting from the nibblings of those codling worms that died on their way into the apple. Wormy apples are not to be sold, but under certain restrictions stung apples can go on the market as lower grade fruit. In as much as a wormy apple shows that the codling moth spray was in that instance ineffective, but a sting usually indicates that the spray accomplished its purpose, we have in the ratio of worms to stings a simple and ready index to judge the merits of the particular treatment. Relatively the more stings there are the better the treatment has proved. It is much easier to express and compare treatments in terms of such index numbers than to keep in mind a series of variable factors, like the previous history and present contamination of the trees, when interpreting results.

To illustrate, a few citations may be made from codling moth spraying data.

No.	Treatment	Total worms	Total stings	Per cent wormy	Ratio worms to stings
1.	None	1,502	79	85.9	18.1
2.	MgAs: 1/100, 1/100, 1/100, 1/100	202	464	16.8	.436
3.	ZnAs: 1/100, 1/100, 1/100, 1/100	70	227	6.5	.308
4.	CaAs: 1/100, 1/100, 1/100, 1/100	135	395	9.2	.292
5.	LdAs: 1/80, 1/80, 1/80, 1/80 . . .	448	1,950	12.2	.276
6.	LdAs: 1/20, 1/50, 1/80, 1/50 . . .	96	348	9.0	.276

The foregoing results were obtained last year on 25-year old Ben Davis trees at Spokane. Judged by the per cent of worminess the lead arsenate spray was inferior to calcium arsenate and zinc arsenite. The coefficient of effectiveness places the lead arsenate treatment first. Comparing examples 5 and 6 one draws the conclusion merely that more larvæ hatched on the trees of 5 in proportion to the number of apples, for the coefficient of effectiveness is exactly the same.

No.	Treatment	Wormy apples	Stung apples	Per cent wormy	Ratio wormy to stung
7.	LdAs: 1/100, 1/100, 1/100, 1/67, 1/50	53	51	1.51	1.04
8.	LdAs and caseinate, same strengths	80	61	1.24	1.31
9.	CaAs and caseinate, same strengths	104	17	1.6	6.12

Citations 7–9 are from Lovett's recent Bulletin 169. Commenting on his results he states "the variations in the percentage of worms in the different plots are so slight as to be within the scope of experimental error, and comparative results are practically nil." However, the index numbers show that the lead arsenate killed proportionally about three times as many worms as did the calcium arsenate. The information in this case is derived from the number of stung and of wormy apples, instead of the total number of stings and of worms. Though possibly less accurate such data may be similarly compared.

Leroy Childs recently presented some interesting figures from his tests of the spray-rod and spray-gun. From the criterion of final worminess his conclusion was that the gun gave best results.

No.	Treatment	Per cent stung	Per cent wormy	Ratio worms to stings
10.	Gun; counts up to 12-ft. level	1.79	.79	.44
11.	Rod; counts up to 12-ft. level	3.9	.97	.25
12.	Gun; counts 12-ft. to top of tree	2.7	3.2	1.18
13.	Rod; counts 12-ft. to top of tree	4.0	3.8	.95
14.	Dust	1.19	3.08	2.60
15.	Unsprayed checks	1.86	12.0	6.45

The coefficient, now obtained by dividing the percentage of worms by the percentage of stings, gives a different interpretation to these figures, and shows that the best results were obtained by the rod on those apples growing not higher than twelve feet from the ground.

No.	Treatment	Total worms	Total stings	Per cent wormy	Ratio worms to stings
16.	LdAs, 1/50; 5 applications, rod..	873	2,643	5.36	.33
17.	Same........................	667	1,954	17.15	.34
18.	Same, gun....................	915	1,726	4.42	.53

Illustrations 16–18 were taken from Mr. Newcomer's results in our last year's coöperative spraying experiments at Yakima. The trees of 16 and 17 were in the same plot, but those of number 17 were adjacent to the block of unsprayed checks; the others were removed by several rows of sprayed trees. Although receiving identical treatment the trees of example 17 showed over three times as many worms as those of 16, but the index number remains the same. In terms of worm-free fruit the gun-sprayed trees excel; the index number, however, shows again that comparative excellence is an illusion and resulted from fewer larvæ hatching on those trees.

These citations illustrate that the ratio of worms to stings affords a more dependable index of the value of codling moth treatment than the customary percentage of final worminess. How far its application will extend will probably be brought speedily to light by investigators stationed over the country. It is applicable for cover sprays and sprayings. The calyx spray must be measured otherwise, for a proper calyx spray leaves no calyx stings. As codling larvæ sometimes nibble here and there, the number of stings is not an absolute indication of the number of poisoned worms. The effect of repellent additions to the spray, or of thickened apple skin in causing the larva to spew out its nibblings, may interfere with the validity of the index number, and the range of such effects should be investigated.

Despite some shortcomings, the coefficient method affords a means for interpreting codling moth treatments from a new angle. No matter how many worms attack a tree, how abundant or shy the crop, whether one or one thousand trees are sprayed, where the trees are located, or how many apples are finally examined, the ratio of unpoisoned to poisoned worms should be an approximately constant guide for evaluating each treatment.

Chairman A. L. Melander: We shall now have the pleasure of an address by M. L. Dean, of the Washington State Department of Horticulture, relative to the work of pest control.

Mr. M. L. Dean defined the special duties of the state officials and stated that the help of all was needed to accomplish the desired results, promising in return complete coöperation.

He also showed some very fine specimens of the egg masses of the fruit tree leaf roller, *Archips argyrospila* Walk., on apple twigs taken from the Bitter Root Valley, Montana.

A full discussion followed.

CHAIRMAN A. L. MELANDER: The next paper is entitled "Symbiosis of Blastophaga and the Fig Family."

SYMBIOSIS OF BLASTOPHAGA AND THE FIG FAMILY

By G. P. RIXFORD, *United States Department of Agriculture*

The great fig family, Ficus of the order Moraceæ, is one of the largest of the vegetable world. Botanists have identified and described more than six hundred species. Most of them are tropical evergreens, frequently of gigantic size, often parasitic or epiphytic. Fraser, speaking of the Morton Bay figs of Australia, said, "I observed several species upwards of a hundred and fifty feet high, enclosing immense iron-bark trees, on which seeds of the fig trees had been originally deposited by birds. Here they had vegetated and thrown out their parasitical and rapacious roots, which, adhering close to the bark of the Iron-tree, had followed the stem downward to the earth, where, once arrived, their growth was astonishing. The roots increase rapidly in number, envelope the Iron-bark, and send out at the same time gigantic branches, so that it is not unusual to see the original tree, at the height of 70 or 80 feet, peeping through the fig as if it were a parasite on the real intruder." The writer has seen the same thing in the tropics of Central America, where the giant fig had strangled the host to death, after which the rapid decay in the moist tropics allowed the torrential rains to wash out the decaying wood through openings in the enveloping fig, until the final result was a giant cylinder, 6 to 8 feet in diameter and 75 to 100 feet in height and 6 inches thick, still vigorously flourishing. The natives called it Matar Palo (tree killer). Other notable forms are the Banian tree, *F. benghalensis*, which sends down aerial roots or branches into the soil where they take root and form new trunks. The Banyan, under which Alexander camped is said to have sheltered 7,000 men, now measures 2,000 feet in circumference and has 3,000 trunks. Another important member of the genus is *Ficus elastica*, a rubber tree. A popular climber in California is *F. repens*, used for covering brick and other walls. Another remarkable species, native of South Africa, produces its fruit under ground. It is thought by some authorities that each Ficus species has its own

parasitic chalcis. Of the Blastophaga more than one hundred and sixty species are known, all parasites on the fig.

The Cultivated Fig

With two or three exceptions all the edible figs belong to the *Ficus carica* species. The number of cultivated varieties probably exceeds one hundred and fifty. One prominent California horticulturist, Mr. J. Leroy Nickel, at one time had over one hundred and twenty-five varieties in cultivation. Of this large number, the Lob Ingir, Turkish name of the well-known Smyrna variety, is unique in requiring pollination to cause the fruit to mature. Linneus and other botanists as early as 1774 reached the conclusion that the caprifig is the male form and all the common varieties, including the Smyrna, the female forms of a diœcious species. The caprifigs are called male, because they contain male or staminate flowers; the common varieties and Smyrnas are females, because they contain only female or pistillate flowers. These fertile or female figs may be again divided into two classes, namely, the Smyrna fig, the flowers of which must be pollinated in order to mature fruit, and the other large class, frequently called the Adriatic class, the fruits of which reach maturity without pollination, but contain no fertile seeds. The latter race includes most of the varieties cultivated in all fig-growing countries.

The Smyrna Fig

The figs of the Smyrna variety never set fruit unless the flowers are pollinated, or, as the process of hanging caprifigs in the Smyrna trees is called, caprification. Therefore the culture of the Smyrna fig necessitates the simultaneous culture of caprifig trees, in which the fertilizing insect breeds.

The fig is not a fruit in the sense in which we regard the apple, peach, etc., but is what is known to botanists as a receptable, upon the inner surface of which are arranged hundreds of unisexual flowers. At the apex of the receptacle is an opening called the eye, or osteolum, which in the young fruit is closed by a number of scales or imbricated bracts. The blossoms are therefore effectually cut off from the outer world, and as the female flowers cannot be supplied with pollen by the wind and cannot polliniate themselves, dependence must be had on the fig insect (*Blastophaga psenes*).

Life of the Blastophaga

The male or caprifig tree has two well-defined crops and a third which is in doubt by some authorities. To these, for convenience, the Neapolitan names profichi (spring crop), mammoni (summer crop),

and mamme (winter crop) have been applied. The mamme crop forms in autumn on the wood of the current season and the Blastophaga from the preceding mammoni oviposits in them when they have reached the size of filberts. By December these mamme fruits are the size of small walnuts and change but little during the winter. The insect hibernates in them in the larval condition and will endure a temperature of 14° or 15° F. without injury. As the weather becomes warm in spring, the insects develop rapidly and are ready to issue in April, when the spring (profichi) crop on the same or other capri trees is in a receptive condition. This crop grows in clusters on the old wood at the extreme ends of the branches and, unlike the mamme, which is nearly spherical, is much larger and usually has a pronounced neck. It is produced in enormous numbers, many times greater than any other crop, a wise provision of nature, as it is the one which is most abundantly supplied with pollen and also the one which is exclusively used to pollinate the main Smyrna crop. The late summer crop of the capri tree, known as mammoni, unlike the others, pushes from the axles of the leaves on the new wood and matures from August to the middle of November. This crop serves to carry the Blastophaga through the late summer and fall months. The Blastophaga from these mammoni figs oviposit in the winter crop, and thus the cycle of the yearly life of the insect is completed.

The Smyrna Fig Dependence on the Insect

The Smyrna fig, by far the best variety in cultivation, is more exacting than the Adriatic class in the relation between climate and fruit production, as its crop of fruit is absolutely dependent on the fertilizing insect (*Blastophaga psenes*), and its culture on a commercial scale is therefore confined to regions where the winters are sufficiently mild to permit the mamme, or winter insect-bearing crop, to live through without injury. Experience shows that if the mamme crop is oviposited in, it will endure about the same temperature as the twigs of the tree to which they are attached. All caprifigs, if not oviposited in, dry up and fall off. The larva of the insect is just as essential to make the caprifigs hold on and mature, as is the pollen to make the Smyrna fig hold on and mature.

The parasitic insect of the *Ficus carica* species, *Blastophaga psenes*, lives but a short time after leaving the harboring receptacle. The female is shining black, has a good pair of wings, and is less than an eighth of an inch in length. The male is brownish yellow and is wingless. It is doubtful if the insects eat at all. In 24 hours after issuing from the caprifig, most of the females are dead, and in 48 hours all have succumbed. Most of the males die in the fig, though considerable numbers crawl out after the females have left.

Fig Pollination

In California the insect, which hibernates in the larval form during the previous few months, reaches maturity in April. The male leaves the gall first. He moves about the interior of the fig, and, finding a gall containing a female, gnaws a hole through the cortex of the ovary at the base of the style and fertilizes the female while she is still in the gall. The gravid female enlarges the opening and sometimes makes another, usually at the base of the style, probably because it is the point of least resistance. In from 22 to 48 hours she leaves the gall, reaching the open air through the cluster of male flowers, the anthers of which at this time have burst and are shedding large quantities of pollen. Her body is moist and sticky and she is frequently so loaded with pollen that she is unable to fly until she divests herself of much of it, in the same way that the common house-fly strokes its body with its legs.

After being relieved of part of the load, she flies to the nearest fig, and if it be in the right condition she immediately seeks the opening at the apex. At this time the figs are hard, and from a quarter to three-quarters of an inch in diameter, and the eye is closed by the overlapping scales. She pushes her head under the thin edges, and after a short struggle makes her way down to the interior of the fig, generally leaving her wings behind.

While one insect is probably sufficient to fertilize a fig, it is not unusual, where they are very abundant, to find a dozen or fifteen in one small fig, and as many more in a struggling mass trying to effect an entrance; often the cluster of wings can be seen radiating from the eye like the plumes of a miniature feather duster. If the caprifig from which the insect has issued has been hung in a Smyrna tree, she enters a Smyrna fig and then finds she has made a mistake, as the flowers are of such shape that she cannot oviposit in them, and after wandering about in a vain effort to dispose of her eggs, in this way doing her useful work of fertilizing the female flowers, in most cases she crawls out. When the weather is warm, say 90° to 100° F., the insects are very active and come out of the caprifig with a rush. The writer has seen forty issue in one minute. The issue takes place almost entirely in the forenoon, unless a cold windy morning is succeeded by a hot sun in the early afternoon, when a considerable number appear. The movement depends much upon the weather. During cool windy mornings very few issue, but if the next morning is warm, calm, and sunny, a great rush occurs. The insects continue to issue from a single fig for a week or ten days if the weather is favorable, and from the figs of various capri trees for two or three weeks.

The Symbiosis

The Symbiosis is one of the most interesting and of the greatest importance known. Walter T. Swingle, in an article in *Science*, says, "the Symbiosis is doubtless one of the oldest known, all of the hundreds of species of figs being inhabited by insects of a special family, Agaonidæ, which are all adapted to their peculiar habitat, while the figs appear as if specially constructed to nourish and protect the insects on which they are completely dependent for pollination." To show the intimate relation, or interdependence, of the insect and plant, it may be mentioned that the larva causes the mamme caprifig to hold on during the winter; furthermore, at the time the female has reached maturity and is ready to propagate the species, the anthers of the staminate flowers of the caprifig have burst, and are shedding quantities of pollen, and as if nature, seemingly to facilitate her exit, the bracts, which previously were flat over the eye, raise up and stand erect, permitting her easy passage. In some of the Ficus species, the male tunnels a passage for the escape of the female from the receptacle.

Smyrna Fig Growing a Promising Industry

The Smyrna fig industry is forging ahead in the great valley of California, and promises to soon become scarcely second to the raisin industry. Within five or six years, hundreds of carloads of dried Smyrna figs will leave the state to take the place of the fifteen or twenty million pounds annually imported from Asia Minor and other fig growing countries. And this great industry will be due to the minute, but beneficent, insect—*Blastophaga psenes.*

Chairman A. L. Melander: The Secretary will now also read a paper by Mr. G. F. Ferris.

INSECTS OF ECONOMIC IMPORTANCE IN THE CAPE REGION OF LOWER CALIFORNIA, MEXICO

By G. F. Ferris, *Stanford University, Cal.*

The Cape Region of Lower California

When the newspapers of the United States speak of Lower California they almost invariably mean nothing more than that portion of Lower California lying immediately south of the United States boundary. The part of the peninsula included in what is known politically as the Southern District is but seldom thought of.

To the extreme southern portion of the peninsula, terminating in Cape San Lucas, scientific writers have applied the term "Cape

Region." Geographically this area is quite sharply defined, coinciding in general with the Victoria Mountains and their foothills and definable practically as the area lying south of a line drawn from La Paz on the gulf coast to Todos Santos on the Pacific Ocean. The mountains rise abruptly to an altitude of as much as 7,000 or 8,000 feet and at the north descend into a low lying plain that at no point reaches an altitude of more than a few hundred feet. Two or three hundred miles of this plain intervene between the Victoria Mountains and the first range of any appreciable altitude to the northward. Owing to the presence of the mountains the rainfall of this area is much heavier than that of the plain and it is about the foot of the mountains that by far the greater part of the agriculture of the peninsula, except the region about Ensenada and the Imperial Valley in the extreme north, is carried on.

There has previously been no information available concerning the insects of economic importance occurring in this area. With the support of the California Academy of Sciences, the Department of Entomology of Stanford University and the United States Bureau of Entomology, the present writer spent some time during the summer of 1919 traveling in this region, and it is upon the observations made during this time that the following notes are based.

Characteristics of the Agriculture

The agriculture of the country is entirely in the hands of natives, there being but very few foreigners and these being engaged in mining or business. The agriculture as a whole is of an extremely sketchy sort. Such crops as demand attention are given such attention as they must have. Such things as will grow without attention are given every facility for doing so.

The principal crops are sugar cane, corn and beans. There is a certain amount of gardening and at San José del Cabo considerable quantities of sweet potatoes are raised. Also in some years tomatoes are raised at San José and shipped to the United States. A very small amount of tobacco is found but it is not produced in commercial quantities.

It is said that cotton was raised at San José del Cabo many years ago, and I saw a few feral plants at this place, but at only one locality, the Eureka ranch at La Rivera, is it now grown. At this point there were a few acres of none too prosperous plants.

The principal fruit is the mango. There are a few limes and not many oranges. Lemons were not seen at all. There are some guavas, avocados and bananas, but not many. Watermelons of a poor quality are plentiful. There are several native fruits that are eaten, but are

never cultivated, among these being the "pitahayas," the fruit of two species of cacti, which are held in high esteem. There are some cocoanuts, but the number is insignificant.

The streams which come down from the mountains in every case sink into the sand as soon as the lowlands are reached, to reappear at some point from a few hundred yards to a few miles from the ocean. It is in the valleys of these streams, before they sink into the sand and after they rise from it (principally the latter), that all the agriculture is carried on. Irrigation from the natural flow of the streams is depended upon, and in but few places is any attempt made to pump water.

Insects of Economic Importance

It is probable that the most important insect in this area is a chinch bug, *Blissus occiduus* Barber (det. Van Duzee), which infests the sugar cane and corn. At the time of my visit it was not especially abundant, but I was informed that at times it takes as much as 20 per cent of the crop. In fact the unusually high price of "panocha" (the crude sugar that is universally used) then prevailing was ascribed to the reduction in the crop caused by its depredations. This species was originally described from Colorado, but as far as I am aware has not been noted as a pest in the United States.

There is also on the corn and sugar cane a Tingid, determined by Mr. Carl J. Drake as *Leptodictya tabida* H. S., which is said materially to assist the chinch bug; and a Fulgorid, determined by Mr. Van Duzee as *Perigrinus maidis* (Ashmead), which apparently does no special damage.

A species of red spider was found in great abundance on beans at San Bartolo, but unfortunately the bottle containing the specimens was lost. At the time of my visit the bean crop had for the most part been harvested and I saw but one small field. In this the spider had killed practically all the plants and I was told that at times it causes a total loss.

In the field of cotton at the Eureka ranch some insect was working in the bolls. At the time of my visit it was too late to obtain specimens and only the work was found. Specimens of this work were forwarded to the Bureau of Entomology, and I am informed that it is a type of injury not before called to the attention of that office.

The nature of this work is as follows: The larva of the insect (one of which was seen) mines in the husk of the boll, sometimes but a single compartment being affected. Occasionally it breaks through the inner epidermis of the husks and feeds upon, or at least marks, the cotton, but in no case had it fed upon the seeds. Nevertheless the

seeds in the affected compartment fail to develop and the lint does not expand upon the opening of the boll, remaining matted and presenting a slightly smutty appearance.

Most of the cotton had been picked and it was impossible to get an estimate of the amount of damage caused by this insect, but it must have been appreciable, especially as the people were well aware of the damage.

Only a few plants of tobacco were seen, these being in a garden at Triunfo, and upon these a weevil, determined by Mr. H. S. Barber as *Trichobaris mucorea* Lec., was fairly common, although it apparently did no damage.

The citrus fruits are suprisingly free from pests, except for the red scale, *Chrysomphalus aurantii* (Maskell), which in some places is extremely bad. I saw also a small infestation of *Lepidosaphes gloveri* (Pack.), but beyond this no insects of any sort were seen on these hosts.

The mango, which in other parts of the world is host to numerous insects is here for all practical purposes free from pests. Aside from a few specimens of *Aspidiotus lataniae* Sign., and an apparently native species of *Asterolecanium,* no scale insects were found upon it. A few specimens of a Thysanopteron, determined by Mr. A. C. Morgan as *Heliothrips haemorrhoidalis* (Bouché), which causes a silvering of the fruit and leaves, were taken from it at San José del Cabo.

There are a number of scale insects on cultivated hosts, few of these of any importance. The black scale, *Saissetia oleæ* (Bern.) was seen, but was taken only from wild hosts and then in no numbers. What is probably *Pseudococcus citri* (Risso) (the specimens were lost) was seen on the fruit of mango at La Paz. *Asterolecanium pustulans* (Ckll.) is common on oleander. *Aspidiotus diffinis* Newstead was taken from guava at La Paz. *Pseudoparlatoria parlatorioides* (Comst.) was found in abundance on guava at San José del Cabo, avocado at Todos Santos and ornamental at La Paz. *Pseudococcus maritimus* (Ehrh.) was taken from a wild host at Cabo san Lucas but was not seen on cultivated hosts. An undetermined species of *Icerya* which I regard as *I. rileyi* Ckll., was found at San José del Cabo on numerous hosts.

An aphid, determined by Mr. A. C. Baker as *Aphis illinoisensis* Shimer, was found on grape at Triunfo but was not abundant.

A Tingid, determined by Mr. Carl J. Drake as *Corythuca gossypii* (Fabr.), was found in some numbers on castor bean at San José del Cabo. I was informed that the tomatoes here are at times lost by the ravages of what is apparently a Sphinx larva. A weevil has been taken from sweet potatoes at the same place but I saw no specimens.

I saw no evidence whatsoever of the existence of any kind of fruit flies within this area. Neither were any Aleyrodids seen on cultivated hosts.

Malaria carrying mosquitoes are present as I can testify from personal experience. I contracted a case of malaria that was diagnosed by a physician on my return to the United States as the tertian form.

The number of insect pests observed is surprisingly small. It is true that the observation of economic insects was but a part of the purpose of the expedition, but I am convinced that enough work was done to reveal all the forms of major importance. The reason is undoubtedly to be found in the isolation of the country and the small amount of traffic between this and other countries in agricultural and horticultural products. As confirmation of this I may note that although the primary purpose of the expedition was to search for scale insects I found but twelve presumably introduced species out of seventy-eight taken, whereas probably nearly half of the species of scale insects known in the United States are introduced.

It should be noted, however, that the time of my visit (July to August) was by no means the most favorable for making obervations in regard to insects, as this is the dry season. Also I may note that in September of the preceding year the country had been swept by one of the most terrific storms "within the memory of the oldest inhabitant." The effects of this storm were still felt and conditions were obviously abnormal. For instance, I was informed that the leaves had been absolutely stripped from the orange trees and that the infestation of red scale had thereby been much reduced. Doubtless the same reduction had taken place in the case of other insects also.

It may be well to call attention to the fact that although this region lies technically within the tropics its fauna bears a very close relation to that of southwestern United States. It is to be expected that any insect which will thrive in the latter area will thrive likewise in the Cape Region of Lower California.

CHAIRMAN A. L. MELANDER: The next paper "The Fitness of the Waters of the Santa Clara Valley for the Making of Spray Solutions," by Mr. E. R. DeOng, will be read by the Secretary.

(Withdrawn for publication elsewhere.)

CHAIRMAN A. L. MELANDER: I have been requested to read the next paper prepared by Mr. A. C. Maxson.

COMBATING THE SUGAR BEET WEBWORM ON A LARGE SCALE

By Asa C. Maxson, *In Charge of Insect Investigations for the Great Western Sugar Co., Longmont, Colo.*

During the growing season of 1919 an outbreak of the sugar beet webworm (*Loxostege sticticalis* L.) occurred in the Rocky Mountain and intermountain states, which, when measured in terms of acres covered and damage wrought far exceeded any previous outbreak of this pest.

In those portions of Colorado, Nebraska, Wyoming, Montana and South Dakota which furnish beets for the Great Western Sugar Co., the first (June) brood of webworms covered 172,728 acres of sugar beets and the second (July-August) brood, 7,567 acres.

The extent of this outbreak, which covered a total of 180,295 acres, afforded excellent opportunity to test the possibilities of coöperation between large manufacturing concerns and the people furnishing the raw material. The object of this paper is to outline the methods used by the Great Western Sugar Company in handling a campaign which covered a portion of four states.

Early in the spring of 1919 preparations were begun to combat the webworms should they appear. These preparations were based upon the outbreak of 1918 which was the largest ever experienced up to that time.

Inability to foresee that the outbreak of 1919 was going to cover an area five times that covered in 1918 was the cause of inadequate preparations. This added much to the difficulty and expense of fighting the worms in 1919 since many sprayers and much insecticide had to be purchased after the campaign was on.

Organization. The entire campaign was directed by the general agriculturist of the Sugar Company. In carrying out the work the following departments and employees of the Sugar Company organization were called upon:

The Purchasing Department. This department located and purchased all supplies of insecticide, spray machines and repair parts for the latter, and supervised their distribution and shipping.

Sugar Company Entomologist. The repairing and general overhauling of all old spray machines and the setting up and testing new machines was under the supervision of the Sugar Company entomologist. General instructions were issued by him to the local management in the various factory territories regarding the time of spraying and quantity of insecticide to use.

The entomologist was assisted by several men who were detailed

as inspectors. These men personally inspected and tested each spray machine in their territory and reported its condition to the entomologist.

Local Mechanical Department. Under the direction of the entomologist the local mechanical department of each factory repaired all old sprayers and set up all new ones.

Local Field Force. The local field force at each factory consists of an agricultural superintendent and several field superintendents or field men. The local agricultural superintendent supervised the work in his territory. In doing this he followed the general instructions given by the general agriculturist and entomologist, using his own judgment in adapting these to his local conditions.

Working under the agricultural superintendent the field men located infested fields and routed the spray machines in that part of the local territory under their charge.

Repairing Farmer Owned Sprayers. During the early spring each field man was required to report the number of spray machines owned by farmers in his territory and their condition.

A list of the needed repairs and repair parts was secured and the Sugar Company assisted the owners in securing these parts. Where the farmer so desired, machines were repaired by Sugar Company mechanics. In such cases the farmer was charged the actual cost of labor and material.

Testing Spray Machines. After the local mechanics had overhauled and repaired all old machines and set up all new ones each machine was tested by one of the inspectors mentioned above.

Owing to there being several makes of spray machines employed and several types and sizes of nozzles used it was necessary to learn just how much spray material was applied per acre by each machine in order to properly mix the insecticide. This was determined by hauling the spray machines along a road or field border until a measured amount of water was discharged through the nozzles. The distance traveled multiplied by the number of rows sprayed furnished the basis for computing the rate of application. In mixing the insecticide the quantity to be used per acre was mixed with the quantity of water applied per acre by the machine. All machines were tested out at 80 pounds pressure.

Field Operations. Several methods were employed in handling local operations. The most successful are outlined below:

Method No. 1. In the territories using this method a man who had assisted in overhauling and setting up machines was detailed as assistant to each field man.

This trouble man, as he was called, was furnished with a Ford auto

and trailer. The trailer was used to transport the sprayers from field to field. This saved much time and wear on the sprayers and insured their delivery at the desired field in good repair.

When not moving machines, the trouble man made the rounds of the machines operating in his territory for the purpose of repairing and otherwise assisting in keeping the machines in operation.

The field man being relieved of the necessity of attending to these details could put in his time locating infested fields. The field man was constantly in touch with the trouble man, directing the movement of the machines from field to field.

Method No. 2. This method required more men than Method No. 1, since a Sugar Company man was with each company owned sprayer in the field. This man kept the machine in running condition and assisted in preparing the poison and filling the sprayer tank.

The one drawback of this method is the danger of the company man becoming poisoned, locally, by constant association with the insecticide.

The field man's part of the work was the same as that in Method No. 1. The machines were hauled from field to field by the farmers, the next farmer in line arriving in the field an hour or so before he was to receive the machine for the purpose of learning as much about its operation as possible.

The relative effectiveness of these methods was practically the same.

A small per acre rental was charged for the use of the sprayer. This was usually 50 cents per acre, this amount being just about enough to pay for the repairs and labor of overhauling and the trouble man.

In the case of Method No. 2 this rental was made large enough to cover the wages of the special man with each machine.

The insecticide was purchased by the Sugar Company, delivered to the growers at cost and charged to their account to be deducted from their pay for beets delivered.

Work Accomplished. As has already been stated, the preparations made to combat the webworm in 1919 were based upon the outbreak of 1918 and were altogether inadequate. As soon as the extent of the 1919 outbreak could be anticipated additional equipment was procured. The unusual demand for insecticides and sprayers made the procuring of the additional supplies slow and costly. At the close of the season the Sugar Company had 303 traction sprayers while the farmers in the Great Western territories owned 471. Many of these were not secured before the season was well advanced so that the acreage covered was not as large as it would have been had the sprayers been on hand at the beginning of the season.

Owing to the difference in the equipment of the machines and other factors which had a marked influence upon the work done by the individual machines, it was necessary to express this in nozzle acres per calendar day in order to get an adequate idea of the work done.

The term nozzle acre per day indicates the number of acres sprayed by one nozzle in one calendar day based on the number of days in the spraying season.

The average nozzle acres per day for all company owned machines was 1.41. At this rate a 12-nozzle machine would cover 16.92 acres per day. During the height of the season such machines covered from 30 acres for 10-hour day to 90 acres per calendar day. Many machines were operated all night. Headlights were placed on them which were run by storage batteries from automobiles.

Sixty-one per cent of the entire 180,295 infested acres were sprayed with company owned sprayers. The Sugar Company purchased nearly a million and a quarter pounds of insecticide during the season.

The results of this attempt at controlling a sugar beet pest through coöperation of the Sugar Company and the beet growers were so successful that in spite of the probable reduction in the number of worms attacking the beets this (1920) season more sprayers are being purchased and several new forms of insecticide are being secured for experimental purposes.

During the season of 1919 Paris green, arsenate of lead, calcium arsenite and several other forms of insecticide were used. The Paris green gave by far the quickest and best results. This was used at the rate of 3.5 to 4 pounds per acre. This appears unusually heavy until we consider the great leaf area of an acre of beets and the need of quick results. Including cost of Paris green, labor and sprayer rental, the cost per acre was about $3.50. A timely and successful application of insecticide would mean, on the average, not less than two tons more of beets per acre. This at $10 per ton, the price paid in 1919, is $20 per acre or a profit of over 400 per cent on the investment.

Chairman A. L. Melander: The paper entitled "Results of Washing Experiments for Control of the European Elm Scale" will be read by the Secretary.

RESULTS OF WASHING EXPERIMENTS FOR CONTROL OF THE EUROPEAN ELM SCALE

By Frank B. Herbert, *Forest Insect Laboratory, Los Gatos, Cal.*[1]

A solid stream of water has been recognized for some time as being of some value in the control of certain soft bodied insects. It has been

[1]Forest insect investigations, U. S. Bureau of Entomology.

mentioned a number of times in its relation to the control of the European elm scale, *Gossyparia spuria* (Modeer).

In 1907, Prof. S. B. Doten carried on a number of experiments with water and obtained satisfactory results in controlling this scale insect upon elm trees in Nevada. In fact he obtained better results than when he sprayed with lime-sulphur or kerosene emulsion. These experiments are listed in Nevada Bulletin No. 65, "The European Elm Scale."

In 1917, it became apparent to Mr. Burke and the writer that the elms at San José, Cal., were suffering considerably from a heavy infestation by this insect. Some of the trees on the State Normal School grounds were well infested. The attention of the head gardener, Mr. Hollingsworth, was called to this fact, whereupon it was decided that control measures should be instituted. The use of water was recommended, with the approval of Mr. Doten and the County Horticultural Commissioner, Mr. L. R. Cody.

It was recommended that this be done in the spring after the females had become quite large, due to being full of eggs, and yet before many of the new elm leaves had unfolded to obstruct the force of water. There is but a short period when these conditions prevail. One gets some warning as to the time to do this by watching the fruit of the elm. The fruit matures and starts to fall a few days before the leaves unfold. This is the best time to do the washing, yet it may be done at any time until the females begin to lay eggs, which is seldom earlier than the last of May. However, some of the force of the water is dissipated when it hits the foliage and consequently the results are not as satisfactory. In 1918, the proper time to do the washing at San José was April 17 to 25.

In preliminary experiments, different sorts of nozzles were tried out upon the garden hose, using the water from the one-inch hydrants upon the Normal School grounds. The maximum pressure available through these pipes was 50 pounds to the square inch at the pump and probably quite a bit less by the time it had reached the nozzle. The best nozzle that could be obtained for this pressure had a rather long taper with an outlet $\frac{3}{16}$ of an inch in diameter. It threw a solid stream and was found to be effective upon the scale insects up to a distance of 12 feet.

On Small Trees

This was used a number of times by the writer and Mr. H. E. Burke in 1918 and 1919 to very good advantage to wash the mature scale insects from young 8- or 10-foot elms. All the limbs were within easy reach and the trees were so small that a thorough washing was possible.

The trunk and each branch and twig were hit with a solid stream of water, most of them receiving it from three directions.

The results obtained were highly satisfactory and these trees remained clean until early fall when young scales from nearby trees crawled onto them to hibernate. Some of the gardeners tried this out upon a number of young elms, but their results were less satisfactory apparently because they were willing to simply wet the trees instead of seeing that a forceful stream hit every branch and crevice from several directions.

On Medium-Sized Trees

It was found by using a 12-foot platform and a 7- or 8-foot extension rod that trees between 35 and 40 feet high could be reached, but since most of the trees had attained a height of 60 to 90 feet, the idea of using this was abandoned. However, one 40-foot tree was washed in this way on April 26, 1918, and was found to be only moderately successful. It proved to be quite tedious work, 1 hour and 40 minutes being required to carefully cover the tree. One year later the tree was apparently infested as badly as ever.

On Large Trees

The next problem which arose was how to obtain a greater pressure and volume of water so as to reach the tops of the larger trees. This was finally settled by the city of San José offering the use of water from their large mains and the loan of a steam fire engine. With the use of these the question of pressure and volume of water was completely solved.

Aside from the engine, the apparatus consisted of 1,000 feet of 2½-inch hose, a short tapered nozzle with a circular ⅞-inch opening, and a stand E to facilitate holding the nozzle. In spite of its name, this is a T-shaped iron bar, the lower end of which is pointed to stick in the ground. The hose is strapped to the upright piece, while the crossbar serves as a handle to be used in directing the stream. This is a very necessary part of the equipment and probably without it the crew would have refused to hold the nozzle for several days in succession. As the engine stood for a long time in one place no method of propulsion was furnished with it, but it was hooked to the rear of the gardener's one-horse wagon when moving was necessary.

At first, a pressure of 100 to 120 pounds to the square inch was maintained and later increased to 160 pounds. This threw a strong stream well above the treetops without doing any harm. In fact it was beneficial, giving the trees a good cleaning by removing all of the dead twigs and branches, besides incidentally giving the trees and

lawns a good irrigating. Even those leaves which had already unfolded were not torn a particle. It was reported that the capacity of this outfit was over 200 gallons per minute.

The crew consisted of one foreman to direct the work, one engineer to run and fire the engine and three hosemen to manipulate the heavy hose and nozzle. The wind caused some trouble by blowing the water back onto the hosemen, but this would have been of little importance had they been dressed in the proper clothes and had not been afraid of the water.

With this apparatus and crew, 191 large trees were washed in six days. This is an average of 15 minutes to the tree. Each tree was thoroughly and systematically covered in this time from at least two sides, each limb being followed out to its tip. This magnificent head of water covered an area a foot and a half square, approximately, by the time it hit the tree. It seemed as though no sort of an insect could be still clinging to a single limb which had been hit by such a deluge. In fact, very few did remain on the trees and these few were well protected by rough bark, a crotch of a limb or some such obstruction.

The cost at that time was as follows:

1 engineer, 6 days at $6.00	$36.00	
3 hosemen, 6 days at $3.50	63.00	
2¾ tons coal at $13.35	36.71	
Actual cost	$135.71	=$.71 per tree

To this should be added the wages of a foreman and the cost of the water. These were both donated in this case but could not be counted on under ordinary circumstances. As this was an experiment, Mr. Hartman, of the Bureau of Entomology, acted as foreman to see that nothing was slighted. The water was very graciously donated by the city. Therefore to obtain the cost of the operation under the usual circumstances, the following figures should be added to the above:

1 foreman, 6 days at $5.00	$30.00	
500,000 gallons water at 12 cents+ per M. (sliding scale.)	63.60	
	$93.60	$93.60
		$135.71
Total		$229.31

This gives an average actual cost of 71 cents per tree or a computed cost of $1.20 per tree, when adding the cost of water and a foreman. This does not include wear or rental of the machinery. One hoseman might be dispensed with, provided the foreman helped move the hose when needed, thus lowering the cost by about 11 cents per tree.

During all the following summer the trees remained quite clean, one or two showing evidence of a few scale insects by a slight drip. The writer estimated that about 85 per cent of the scales had been removed. However, one year later the trees were infested almost as badly as before the washing. Part of the reinfestation was due probably to the migration of young insects from all the surrounding well infested trees and partly from the estimated 15 per cent of insects left on the trees after the washing.

Conclusions

From these experiments the writer has concluded that the European elm scale on small trees can be treated very satisfactorily with the garden hose and nozzle and an average force of water. This is slower than spraying but is often easier than going to the trouble of obtaining the necessary apparatus for spraying where only a few trees are to be treated.

With larger trees it is necessary to obtain a larger volume of water at a higher pressure in order to produce satisfactory results. This can be obtained by using a fire engine, but is recommended only when a large capacity power spraying outfit is not available. The former is cheaper but somewhat less effective.

The ordinary orchard spray outfit is satisfactory for trees up to 35 or 40 feet high, but larger shade tree sprayers are made which will reach 90 feet high or more. Trees 60 or more feet high would require 30 to 40 gallons or perhaps more of spray material if properly covered, which would cost probably 5 cents per gallon by the time it was applied. Therefore the cost of spraying would be 25 to 50 per cent higher, but would probably be more satisfactory under the proper conditions.

Chairman A. L. Melander: The meeting will now adjourn to meet at the same place tomorrow morning. Adjourned.

Morning Session, Friday, June 18, 1920

Chairman A. L. Melander: The first paper will be read by the Secretary, entitled "The Spread of the Argentine Ant in Southern California," by R. S. Woglum and A. D. Borden.

(Withdrawn for publication elsewhere)

Chairman A. L. Melander: The next paper on the program is "Migratory Instincts of the Blue Bottle Maggots, *Phormia regina*," by A. C. Burrill and H. L. Jones and will be read by the senior author, Mr. Burrill.

(Withdrawn for publication elsewhere)

CHAIRMAN A. L. MELANDER: Mr. R. S. Woglum and M. B. Rounds have sent in a paper which will be read by the Secretary.

DAYLIGHT ORCHARD FUMIGATION

By R. S. WOGLUM and M. B. ROUNDS, *U. S. Bureau of Entomology*

Orchard fumigation of citrus trees in this country has, with few exceptions, been confined strictly to night operations from the earliest days of its commercial adoption. During hot weather trees have not been covered until sundown, but with the advent of cool weather in late autumn, fumigation was frequently started while the sun was still up; and in winter full exposure to gas was sometimes made on cool days. Occasionally a venturesome fumigator attempted daylight work in the winter without regard to temperature and, although temporary success sometimes followed, sooner or later severe injury was experienced and return to the night practice invariably followed.

In 1918 a situation arose in California which necessitated prolongation of the fumigation season well into the winter and an outgrowth of this in Orange County was a large amount of daylight work, in part performed in the bright sunshine at comparatively high winter temperatures. This was carried on without experiencing the severe injury which had always proved a check in former years. One operator in particular was so impressed with the possibilities of daylight work that he practically abandoned night fumigation throughout the season of 1919. The past winter, 1919–20, saw an additional number of outfits fumigating very extensively during the daytime.

A special investigation of daylight fumigation was started by the writers in 1919 with the object of ascertaining the reasons for the greater freedom from injury at the present time with liquid hydrocyanic acid than in former years under the pot and machine methods of generation, and also of determining if a system of daylight fumigation both practical and safe could be developed. Partial results of this investigation are presented herewith.

Prior to 1916 orchard fumigation was performed with a highly heated gas generated in the field. The introduction of liquid hydrocyanic acid was accompanied by a new method of field application which produced a cool gas at the lower part of the tree and resulted in very different diffusion from that of the heated field-generated gas. This was pointed out by the senior writer[1] who showed that at warm temperatures the scale-kill in the case of pot-generated gas is best toward the top of the tree whereas with liquid hydrocyanic acid it is best toward the bottom. Gas concentration is proportional to scale-kill.

[1] JOUR. ECON. ENT., V. 12, No. 1, 1919.

Injury from daylight work is confined largely to the sunward side of the tree and its intensity at different heights is governed in great degree by the concentration of the gas during the exposure. This condition frequently reflects the method of generation, in the case of pot-generated gas the greatest injury being toward the top of the tree, the part of greatest concentration, whereas trees fumigated with liquid hydrocyanic acid usually exhibit injury most severe lower down on the sunward side.

It is well known that at high temperatures hydrocyanic acid is more toxic to plants than at low temperatures. Therefore, a knowledge of heat conditions within the tent at the time of treatment is essential to a correct understanding of its bearing on plant injury. Table I shows the comparative temperatures at different parts of a tented tree in the sunshine at varying periods after covering.

TABLE I —SHOWING THE COMPARATIVE TEMPERATURES AT DIFFERENT PARTS OF A 12-FT. ORANGE TREE AFTER COVERING WITH AN 8-OUNCE ARMY DUCK TENT ON A BRIGHT SUNSHINY DAY IN DECEMBER. RECORDS TAKEN 6 TO 10 INCHES FROM THE CLOTH

Time	Sunward side (S.)		Shade side (N.)	Outside tent
	Top 11 feet	Bottom 4 feet	Bottom 4 feet	Direct sun
11.00 a. m.	69° F.	69° F.	66° F.	69° F.
11.05 a. m.	76	72	68	69
11.10 a. m.	82	79	68	69
11 15 a. m.	87	82	70	70
11.20 a. m.	91	83	71	71
11 30 a. m.	92	83	72	71
11.40 a. m.	93	83	73	72
12 00 a. m.	95	85	74	72

An examination of this table shows that the temperature within the tent on the sunward side rises rapidly for the first 15 or 20 minutes following covering, the increase at the top of the tent after 20 minutes being 20 degrees higher than the outside air, an average that was slightly increased during the last 40 minutes of the exposure. The temperature at 4 feet on the sunward side was much lower than at the top. It is of particular interest to note that the maximum temperature increase on the shaded side of the tree at 4 feet was only 5 degrees greater than the normal increase of the air temperature outside the tent and, as compared with the maximum increase near the top, sunward side, was 21 degrees less than this extreme. Therefore, it is evident that the temperature of a tree covered in the daytime is greatly increased on the sunward side especially at the top although the shaded part shows little increase above the outside air.

Holding in mind that a strong gas is more injurious than a weak one, and also that toxicity increases with the temperature, it is readily seen that in the case of pot-generated gas where the greatest strength

is toward the top of the tent, which is also the point of the highest temperature, there is concentrated a maximum of influence for injury. Turning to the use of liquid hydrocyanic acid quite the reverse is true. The gas becomes weaker toward the top of the tent, the part of highest temperature, and the most concentrated gas is toward the bottom where the influence of the sunshine is less felt. Between these two factors, temperature and gas concentration, the latter appears to be the more dominant, for as a general rule the greatest injury to trees fumigated in the sunshine with liquid hydrocyanic acid is centered about half way up the tree on the sunward side. In all cases the injury is decidedly less than with pot-generated gas. The shaded side with its more normal temperature and without the sun-influence is seldom modified to any great degree either in point of injury or scale-kill over that normal to an equal temperature at night.

Scale-Kill in Different Parts of a Tree Fumigated in the Sunshine

The scale-kill is by no means uniform throughout a tree fumigated in the sunshine but rather irregular and reflects the effects of varying temperature and gas concentration at the different parts. This is shown in the following table which gives the results based on five trees infested with black scale which were fumigated March 3, 1920, with liquid hydrocyanic acid. The scale was in the rubber stage, approaching maturity, a condition in which they are very difficult to destroy and which require sharp influences to detect distinct differences in mortality. The insects were taken from outside branches and averaged 200 to 500 for each count.

Table II—The Scale-Kill in Different Parts of 12-Foot Trees Fumigated[1] with Liquid Hydrocyanic Acid in the Sunshine with a Full Dosage Schedule for 50 Minutes, March, 1920

Tree No.	Per cent killed		
	Sunward (S.) 3 to 6 feet	Top (N.)	Shade (N.) 2 to 4 feet
1	75	36	47
2	96	87	70
3	94	17	20
4	75	11	14
5	84	36	25
Average	84	30	27

These results show the scale-kill on the sunward side of the tree at 3 to 6 feet to be greatly superior to that on the shaded side both low down as well as at the top. In fact the mortality on the shaded part

[1] Jour. Econ. Ent., V. 12, No. 5, p. 361.

of the tree averaged less than one-third as high as that at the point of greatest mortality on the sunward side. A large number of other trees which were similarly fumigated showed decidedly increased mortality on the sunward side. The scale-kill at the top of the tree appeared to be modified somewhat by its shape. As a general rule the kill at the top was noticeably superior on the part toward the sun. The sunward part of the top, however, was decidedly inferior to that nearer the bottom on the same side. While the kill at the top, sunward side, was superior to that of all shaded parts of the tree, there appeared to be no constant superiority one way or the other between the top and bottom on the shaded side. Illustrated by an average dome-shaped orange tree 12 feet tall, the highest scale-mortality in sunshine fumigation during the winter is at the periphery of the tree in the direct path of the sun and about 3 to 6 feet above the ground. The mortality appears to decrease in all directions from this point and is lowest on the shaded north side, which is least influenced by temperature changes. The scale-kill in sunshine work at any time at best must be very irregular since it is influenced directly by temperature and this varies in different parts of the tree. Furthermore, the ratio of the temperatures at different parts of a tented tree to each other changes with the position of the sun at different hours of the day as well as its angle to the horizon at different seasons of the year.

The Influence of Tenting Material

Eight-ounce special U. S. army duck is considered the most satisfactory gas-holding cloth used in commercial fumigation, and tests by the senior writer have demonstrated its superiority to drills in night fumigation. Tents are frequently dipped in tannin to prevent mildew but it has been determined by experimental night fumigation that this in no way increases their gas-holding quality. Therefore, it was a matter of considerable surprise to ascertain superior kill in sunshine fumigation with tannin-treated drill tents than with eight-ounce army duck.

Table III—Showing Comparative Scale-Kill from Sunshine Fumigation with Liquid Hydrocyanic Acid Under Tannin-Treated 6¼-Ounce Drill and Untreated 8-Ounce Duck Tents. Immature Black Scale. Full Schedule. Exposure 50 Minutes. Outside Temperature 68°—70°, March, 1920

	No. trees	Per cent killed		
		Shade (N.) 1–3 ft.	Sun (S.) 2–6 ft.	Top
Tannin-treated drill	2	99.3	99.6	99.2
White duck	3	92.7	99.5	97.7

The above table presents the results of experimental work in which five orange trees of equal size infested with immature black scale were fumigated with liquid hydrocyanic acid according to the same dosage schedule and for the same exposure. Two trees were covered with tannin-treated (dark colored) 6½-ounce drill and three trees were covered with 8-ounce untreated duck. The results of the fumigation show that the dark-colored tents gave the best scale-kill, this superiority being most evident on the north side of the tree. This difference in mortality in favor of dark-colored tents was even more effectively brought out where the maximum scale-kill departed more widely from the point of eradication than for the above trees. For instance, one set of trees given a 30-minute exposure averaged 95 per cent scale-kill on the shaded side of the trees fumigated under dark-colored drill tents but showed only 76 per cent scale-kill at the same position on trees fumigated under untreated duck tents.

This difference in scale-kill between the dark and light tents appeared attributable to the higher temperatures within the former. This condition is shown by the following table in which is recorded the temperature at different points within a tannin-treated drill tent as well as a white army duck tent.

Table IV—The Comparative Temperatures at Different Parts of Two 12-Foot Trees, One Covered with a 6½-Ounce Tannin-Treated (Dark Colored) Tent and the Other Covered with a White 8-Ounce Army Duck Tent. May 18, 1920, 9–10 a. m. Records Made at 10 Minute Intervals. Thermometers 6–8 Inches from Tent

Time	Outside temp.		Sunward 3½ ft.			Sunward 11 ft.			Shade (N.) 3½ ft.			Middle 3 ft.		
	Sun	Shade	Dark tent	Light tent	Dif.	Dark tent	Light tent	Dif.	Dark tent	Light tent	Dif.	Dark tent	Light tent	Dif.
Start	82°	78°												
10 min.	85	79	90°	87°	3°	97°	95°	2°	84°	79°	5°	83°	79°	4°
20 min.	85	80	93	89	4	104	101	3	87	81	6	86	82	4
30 min.	87	82	95	90	5	108	104	4	89	82	7	88	82	6
40 min.	88	83	98	91	7	110	106	4	90	83	7	89	83	6
50 min.	86	85	97	91	6	110	106	4	91	84	7	90	84	6
60 min.	89	85	99	92	7	112	108	4	92	85	7	91	85	6

Not only is the temperature higher at all points within a dark colored tent, especially on the shaded side where the average difference amounts to 6 or 7 degrees, but there appears to be an influence on the gas diffusion due to the heat factor which interferes with its escape through the tenting and this influence is most apparent under the darker tent. So noticeable is this difference in gas retention between the two types of tents that it is readily detected by the smell at the end of a normal exposure. In our experimental work during the winter it was observed that one could stay beneath an 8-ounce untreated duck

tent with safety and without annoyance at the end of a 50-minute daylight exposure so little gas remained, but on the other hand this was seldom possible beneath the tannin-treated tents especially on the sunward side, because of the greater volume of residual gas. Particularly of interest is the tendency of the gas to remain strongest on the hot sunward side of the tree and to escape more freely from the cooler portions.

As a possible explanation of this situation it can be stated that the sun falling on the tent produces a very rapid rise in temperature, which is greatest immediately beneath the cloth and decreases as the distance away becomes greater. The cyanid gas is cold when entering the tent at the lower and cooler part. As it diffuses with the air and rises the mixture comes in contact with the hotter air on the sunward side but appears to be retarded in escaping from the tent on this side by the very highly heated peripheral layer of air immediately adjacent to the cloth. Dark colored tenting intensifies the temperature of this layer.

TABLE V—TEMPERATURE COMPARISON ON SUNWARD SIDE OF THE PERIPHERAL LAYER OF AIR INSIDE TWO TREES COVERED RESPECTIVELY WITH LIGHT AND DARK COLORED TENTS. RECORDS TAKEN 11 FEET ABOVE GROUND ONE HOUR AFTER COVERING

Light tent 8-oz. army duck			Dark tent 6½-oz. drill		
Temp 6–8 in. from cloth	Temp. immediately adjacent cloth	Difference	Temp 6–8 in. from cloth	Temp immediately adjacent cloth	Difference
106°	118°	12°	114°	142°	28°

The dark colored tent shows the remarkable difference of 28 degrees between the temperature immediately adjacent the cloth and that distant 6 to 8 inches; the white tent only 12 degrees. Records taken simultaneously at 3½ feet on the shaded side of the tree gave temperatures of 92 and 85 degrees respectively for the dark and light tents. When these latter records are compared with those taken immediately adjacent the cloth on the sunward side there is presented the very great difference of 50 degrees between the extremes of temperature within the tannin-treated tent and 33 degrees within the white tent.

The temperature of the air on the shaded or north side of the tree covered with the white tent almost paralleled that of the outside air and in the case of the dark tent was but 6 to 7 degrees higher. Therefore, the absence of a hot layer of air on the shaded side immediately adjacent to the tent allows the gas to diffuse outward as freely over this area as at night.

Comparison of Day and Night Fumigation

The effect of the gas on the scale and the effect on the plant both demand careful attention in a comparison of daylight and night fumigation and one ordinarily acts as a balance on the other in recommending or condemning the practice. From the standpoint of scale-kill, night practice can be differentiated from sunshine practice by the comparative results at different parts of the tree, and in the accompanying table is presented such a comparison for experimental work performed against the black scale.

Table VI—Comparison of Night and Sunshine Fumigation Against Immature Black Scale, Using a full Dosage-Schedule in March, 1920. Each Set of Figures Represents the Average of Five Trees.

Time	Temperature	Exposure	Per cent killed	
			Shade (N.) 2–4 ft.	Sun (S.) 2–5 ft.
Night	46°	50 min.	93	94
Sunshine	69	50 min.	95	99
Sunshine	71	30 min.	82	98

A study of this table shows that sunshine work at a temperature of 69° was decidedly superior to the night fumigation at 46 degrees. This superiority was due unquestionably to temperature differences. Experiments performed by the writers show that in night work better scale-kill occurs at higher temperatures than at low temperatures. The results in night fumigation are quite uniform throughout the bottom of the tree whereas daylight work gives the best kill on the sunward side where the temperature influence is greatest, as previously stated. Additional experiments carried out against mature black scale showed an even greater difference in mortality between night and day work, the superiority always being most outstanding on the sunward side.

Trees with a 30-minute exposure were fumigated in the sunshine simultaneously with those given a 50-minute exposure. These results, which are presented in Table VI, are of interest in showing that on the sunward side the kill is but slightly inferior to that for a 50-minute exposure whereas on the shaded side of the tree it is decidedly inferior, at this point giving an 82 per cent scale-kill against a 95 per cent kill for a 50-minute exposure. Comparing a 30-minute sunshine exposure at 71 degrees with a 50-minute night exposure at 46 degrees, the results of the daylight work are seen to be superior on the south side of the tree but decidedly inferior on the north side. In view of the

uniformity of results throughout the bottom of a tree fumigated at night, whereas in sunshine work the poorest kill is in the more shaded part which is also usually most severely infested, the figures just presented would appear to show that a 50-minute night exposure at a cool temperature is, under some conditions, superior to a 30-minute sunshine exposure at a much higher temperature.

The greater effectiveness of daylight fumigation to that at night with the same dosage and exposure is clearly evident. The temperature averages many degrees higher during the day which correspondingly increases insect activity as well as susceptibility to the gas. This superiority is most noticeable on the sunward side of the tree. In this connection it must be noted that the severest infestations of such scales as the black and purple are on the more shaded parts of the tree where the superiority of sunshine work is least apparent. This condition is of primary importance in regulating any reduction of dosage for sunshine work, for to accomplish results with a reduced schedule equivalent to night work such reduction of dosage must be made with regard to the scale-kill on the shaded part of the tree where it is most difficult to destroy. The irregularity of scale-kill is one of the greatest drawbacks to the daylight practice.

Factors Limiting Daylight Work

Sunshine coming in contact with plants immediately after fumigation and before they have fully recovered their normal physiological activity is a factor of the greatest concern from the standpoint of injury. In fact there appears to be no other meteorological condition which so intensifies plant injury. Therefore, in conducting daylight fumigation one is constantly menaced with a factor of great danger. The effect of the sunshine is modified by its intensity (this depends mainly upon the height of the sun above the horizon and the clearness of the atmosphere), by the physiological condition of the plant, by the concentration of gas and by the length of exposure. Thus in entering the field of daylight fumigation we are entering a field of complex nature. Of these factors the strength of gas, the length of exposure and the temperature or intensity of the sunshine are entirely tangible and necessarily form the basis of daylight fumigation procedure. Any plant will withstand a certain amount of gas under the most severe conditions without injury, and within certain limitations this concentration is safely increased as the length of exposure is decreased. This very point appears to be the keynote to successful daylight fumigation. Night fumigation with dosage schedule $\frac{3}{4}$ and No. 1[1] has been followed with safety for many years with exposures

[1] Bul. 90, Bur. Ent., U. S. Dept. Agr.

ranging from 45 minutes to one hour, yet the attempt to transplant these dosages and exposures to daylight fumigation under the pot-system has invariably been disastrous.

It has been explained that the more successful use of liquid hydrocyanic acid than pot-generated gas in daylight work is possible because of differences in diffusion which, in the former case, places a weak gas at the top of the tree, the part of greatest heat. This diffusion, together with possible differences in physical properties of the gas, has appeared to render the transfer of night practice to daylight practice possible with a reasonable degree of safety during the winter months when the trees are in a dormant condition. Especially is this true for lemons to which no particular injury has occurred during the past winter's fumigation.

Throughout the summer and autumn trees are very active and the sunlight intense, both of which render fumigation at this time a very precarious practice. However, fumigation can be done even under the most severe combination of conditions provided the dosage is reduced or the exposure shortened sufficiently to offset their influence. Of course, if the reduction of dosage or exposure necessary to offset the injury factor reduces the scale-kill below commercial requirements the operation is a failure.

Injury from daylight fumigation is characterized by leaf drop, particularly on the sunward side of the tree and in severe cases by bleaching of green fruit. The fruit pit so prevalent in night fumigation is infrequent in daylight work. Ripe fruit does not appear to be affected at all and trees have been observed defoliated without the colored fruit being injured in the least. Bleached fruit, if not too severe, may later recolor and appear unblemished, but severe burns reduce the grade. It is scarcely possible to conduct sunshine fumigation without considerable leaf drop. Therefore, one of the most important considerations in attempting this practice is to determine the amount of foliage that can be dropped without injury to the tree. On this growers are at variance.

The writers have taken many records of fumigation during the active autumn period at temperatures upwards to 80° F. with exposures averaging 30–40 minutes. Dosages as high as 78 and 89 per cent schedules were used. Such practice was in general very effective against the red and black scales, but the injury to the trees was frequently very severe, and in some cases gave almost complete defoliation. The injury in the early morning and late evening was less intense than during the hottest part of the day. By sharp reduction of the dosage and exposure to offset the increased intensity of the sunshine numerous orchards were fumigated at this active period without

severe injury, and particularly was this true for lemons, which appear to be far less susceptible to sunshine fumigation than are oranges.

On the other hand parts of orchards would sometimes be greatly injured even with a dosage and exposure in no way severe to the same varieties in the adjoining orchards. Such differences in injury are attributable to varying soil conditions and the physiological condition of trees, and in this we find one of the greatest drawbacks to daylight work, for it appears to intensify injury to trees least resistant to gas to a much greater extent than does night practice.

Conclusions

The writers have carried on experimental daylight fumigation with liquid hydrocyanic acid from the middle of the active fumigation season in October throughout the winter period. As a result of this work they are convinced that, where practicable, daylight winter fumigation is preferable to night work. At this period the insects are especially difficult to kill on cool nights. Furthermore, the trees are in a dormant condition and can withstand a stronger gas even at temperatures approximating 80° F. Particular attention should be given to the exposure.

While the data accumulated during the past season shows that an experienced and careful operator with a few tents can by constant manipulation of dosage and exposure practice daylight work during the growing season, especially on lemons, with partial success, such practice in preference to night work cannot be recommended at the present time. Experience has proved that fixed dosages and exposures are the safest guides to effective fumigation and the necessary data has not yet been accumulated to establish this condition for daylight summer and autumn work. In fact there is considerable doubt if a fixed dosage-exposure combination can be developed which is practical under the extreme varieties of daylight weather during the usual fumigation season, a situation which is further emphasized by the widely differing conditions between the hot interior valleys and the cooler, more humid coastal belt.

Chairman A. L. Melander: We are now prepared to show you three reels of motion pictures illustrating "Beekeeping in the National Forests," by G. A. Coleman. The pictures were screened by the chairman.

Chairman A. L. Melander: The final part of the program will be concluded by Prof. Trevor Kincaid who will briefly discuss "The Earwig Problem About Seattle." (No report was made of this talk by the Secretary.)

CHAIRMAN A. L. MELANDER: This concludes the program. The meeting stands adjourned, it being understood that we meet next year with the Pacific Division of the American Association for the Advancement of Science, as we have done this year, the meeting scheduled to be held at San Francisco, Cal.

Meeting adjourned.

E. C. VANDYKE,
Secretary.

MEXICAN BEAN BEETLE SITUATION

By W. E. HINDS, *Auburn, Ala.*

In the October, 1920, issue of the JOURNAL, pp. 430–431, appears a brief statement regarding the discovery of *Epilachna corrupta* Muls[1] in Alabama. Scouting work continued through September and October revealed the species in all, or parts, of thirteen counties. This infested area extends in a northeasterly direction from the eastern part of Tuscaloosa County and the northern part of Bibb County to the Georgia Line at the northeastern part of DeKalb County, Alabama. The area infested covers more than 4,500 square miles.

A special effort was made to secure an emergency appropriation of $250,000 from the special session of the Alabama Legislature, which met in September, to begin a campaign for the extermination of the pest in this section. This effort failed as it required a two-thirds vote to carry at a special session. Unfortunately no federal funds are available for such work at this time. With the delay incident to securing federal action there would doubtless be time for the spread of the pest during another season, thereby making the extermination of the species doubly difficult, if not quite impossible.

Meantime field work has been under way in studying the life history and insecticidal control of the bean beetle. Control efforts have proven very ineffective with all materials tested thus far. Arsenicals act primarily as repellents and exert some benefit in this way, but may not prove effective in saving a crop from practically complete destruction. It now appears that quite new materials and probably some new machinery and new methods for their application may be needed to solve this problem of control.

Among the food plants, the common bush snap beans appear to be most severely injured, and the loss is likely to be complete henceforth except for a partial yield from the earliest planted beans. This is almost equally true as regards pole beans and shell beans. Lima beans

[1] For several reasons it seems that the common name Mexican bean beetle should be used instead of bean ladybird.

develop later and in newly infested territory especially have usually made a partial crop, but certainly less than a half crop. The new food-plant, cow peas, has been so heavily attacked in some fields as to reduce the yield of hay at least 30 per cent by weight, and the feeding value would be decreased even more than that. In some cases Calfornia black-eyed peas have been completely destroyed. Soy beans have also suffered heavily in some fields, but the infestation has not been as general on soy beans as on the other food plants. While Kudzu has not been attacked noticeably in the field, complete development of the insect has been obtained under confinement upon that plant. Fortunately no wild food plants have yet been found, and no field attack upon velvet beans, although slight feeding has occurred in confinement.

The life history in the East appears to be quite different from that recorded in the West where the insect has occurred at high altitudes and under semi-arid conditions. Here the growing season is much longer than there and the breeding of the insect apparently begins much earlier in the season and continues much later. In Alabama breeding is certainly continuous until killing frosts occur. Freshly laid eggs have been found well into November, but development is, of course, retarded and reproduction less abundant than earlier in the season. While only two generations occur in the West, it seems certain that three or four occur in Alabama, and the capacity for damage will be correspondingly increased.

The proportion of hibernating adults surviving the winter under Alabama conditions is under investigation with some 8,000 beetles in the various tests. The hardiness of the species is indicated by the fact that submergence under water for twenty-four hours did not kill any of them, although forty-eight hours was fatal to all, and also by the fact that exposure to HCN fumigation at standard strength and time for the treatment of nursery stock did not kill more than one-fourth of the adults tested.

The Alabama State Board of Horticulture has established a quarantine covering the known infested area and also an adjoining safety zone approximately twenty-five miles in width, and prohibits the movement from this area of the following materials or articles when produced within the quarantined area:

1. All possible food plants or other fresh materials most likely to aid in disseminating the pest. This list includes all fresh beans and cow peas of any kind and soy beans, but not English peas, velvet beans, or thoroughly dried and cleaned beans or peas of any kind.

2. From April 1 to November 30 each year, all forms of "greens," or fresh edible plant leaves, such as those of mustard, spinach, chard, turnips, beets, collards, cabbage, lettuce, etc.; green corn ("roasting

ears"); and between October 1 and May 31 each year, all matured corn in the shuck unless in carload lots and fumigated as may be required by the Board. There are no restrictions, however, on root crops from which the tops have been removed completely, or upon peanuts, tomatoes, canteloupes, watermelons, berries, grapes, nuts or tree fruits.

3. Hays and similar forage crops, including corn stover.

4. Nursery stock, except when such stock and packing materials have been so treated as to destroy the Mexican bean beetle in all stages or in hibernation.

Similar quarantine regulations will probably be adopted by the Federal Horticultural Board and by such states as may establish quarantines. Uniformity in the matter of requirements is highly desirable, and the Alabama quarantine embodies all of the restrictions which have been agreed upon in the several conferences held by the cotton states entomologists and agents of the Bureau of Entomology and the Federal Horticultural Board. The quarantined area is already an interstate matter, as the safety zone extends for about twenty-five miles into the northwestern corner of Georgia.

Of course quarantines can only retard the spread of the bean beetle by commercial agencies. The annual dissemination by flight is certain to continue, as has that of the Mexican cotton boll weevil. But the area to be invaded by the bean beetle will very certainly exceed by far that affected by the boll weevil. It will be more like that now infested by the Colorado potato beetle. There appears to be no natural barrier, geographical or climatic, to prevent its steady spread even to the northern and eastern limits of the United States, and possibly to any section where beans are grown abundantly. The navy bean crop of the country seems likely to suffer very seriously.

The prospect for the future is not bright. The state and federal funds available appear to be entirely inadequate for such prompt and complete study of this pest as its importance demands. Control by parasites and natural enemies is not at all probable, as the bean beetles are repellent to birds and seem to have very few enemies even in their western habitat where they have occurred for forty, or more, years. Possibly some natural enemies might be found in Mexico where the species seems to have originated, and a diligent search for them should be made in that country as soon as possible. Those who have studied the situation most closely seem agreed that the entire agricultural system of the United States, in food and forage products and in the renewal of soil fertility, has never been so seriously menaced by any native, or introduced, insect pest, as it is now by the spread of the Mexican bean beetle.

A STUDY OF THE EFFECT OF COTTON WORM ON BOLL DEVELOPMENT AND COTTON YIELD

By F. L. THOMAS, *Assistant Entomologist, Alabama Experiment Station*

During the summer and fall of 1919 the writer was engaged in carrying on cotton dusting experiments at Prattville, Ala., on the plantation of the McQueen Smith Farming Co.

While examining cotton on selected plots during the first week of August several small caterpillars of the cotton worm moth were found. In four or five days the worms were very abundant and apparently in all stages of growth on cotton which had not been poisoned. By the 11th of August the worms had begun to pupate.

The cotton on this plantation had received a heavy application of ammonia fertilizer and the unusually wet year caused the cotton to take on a rank, heavy growth usually characterized as "mostly weed" or "gone to weed."

The first generation of worms that was noticed in this locality finished their work about August 18. The cotton plants were ragged from the work of the worms, but the general opinion of tenants and owners was that more good had been done than harm. The "ragging" allowed more light to get in and would prevent many of the bolls from rotting, they said.

On the 7th, 8th, and 9th of September the second generation completely stripped the cotton in fields where the worms appeared. In this connection it is interesting to note that the moths, adults of the first generation, were attracted to the richest uninjured cotton for laying eggs of the second generation. In many fields already ragged practically no further injury occurred. The cotton on which calcium arsenate had been applied for control of the boll weevil, retained its foliage. A third generation was expected, but did not develop, although the eggs were laid. Control was due to the natural parasites which became very abundant.

With entire fields looking brown, the first impression was that the damage had been great. After examination, expression was frequently given by the above-mentioned parties and others, that the damage was more apparent than real and that it didn't hurt them.

The opportunity was at hand to get some reliable information on this point under conditions existing at this time and place.

One hundred and twenty-three stalks, newly stripped by cotton worms, were selected and tagged and found to possess 1,255 unopened bolls of all sizes. For comparison, two rows in a plot of treated cotton with foliage uninjured and in the same field were selected; these rows contained 250 stalks. All open bolls on plants and rows selected were

picked at the beginning of the test, September 11. None but perfectly formed bolls were included in the weighings, thereafter. When affected by weevils the boll was discarded. Seven pickings were made covering a period of one month. At the end of that time there were still 133 green, unopened bolls on the stripped plants and with very few exceptions all the plants in the devastated area were putting out new leaves from top to bottom. On October 15 other duties interfered and opportunity to examine these plots again did not occur until December 5. Many unopened and half-open bolls were found on plants that held their foliage until frost came and stopped development.

At the beginning of the test 100 wide open fully matured bolls from plants that did not lose their foliage weighed 21 ounces, and the same number of similar bolls from plants that had lost their foliage weighed 19 ounces. It was not expected at this early date, two days after stripping, that any difference in weight could be attributed to cotton worm work. It would seem to be a natural variation.

The following record of pickings and weights is interesting:

	9/9 Foliage Uninjured, 250 Plants				Stripped of Foliage, 123 Plants			
Date	No. of Bolls Picked	Weight Oz.	Boll Weevil	Small Dried Up	No. of Bolls Picked	Weight Oz.	Boll Weevil	Small Dried Up
9/13	63	12.5	Discarded bolls		92	17.5	Discarded bolls	
9/16	50	8 0			203	36 5		
9/19	42	8 0			71	12.5		
9/23	80	14 0			161	27.5	40	
10/1					87	12.0	40	37
10/2	76	12.0	6	25	119	18 0	52	46
10/14	108	16 5		48	156	22 0		
	419	71.0	6	73	889	146.0	132	83

Average weight of 100 bolls from the stripped plot 16.42 ounces.

Average weight of 100 bolls from plot with the foliage uninjured 16.94 ounces.

All but 16 bolls out of 1,255 can be accounted for on the 123 plants in the stripped plot.* No record was made of the entire number of bolls on the 250 plants in the plot with uninjured foliage. On both plots the opening bolls were of all sizes.

No significance is attached to a comparison of the number of bolls damaged by the boll weevil on the two plots. Accurate record was not kept in the plot with foliage uninjured. The weevil-injured bolls were left on the plants for the tenant to pick.

The dried-up bolls were all small and found on both plots, but were more readily seen on the stripped plants than on those with leaves.

* Two bolls were injured by cotton worms and discarded.

Summary and Conclusion

The loss of foliage from ravages by cotton worms does not kill the cotton plants.

Stripping by cotton worms results in the much earlier maturity of unopened bolls.

There is practically no loss in weight of bolls maturing on plants without foliage.

With a killing frost occurring normally at an average date of November 10 for this locality, after which development ceases, the following conclusion is drawn:

Under boll weevil conditions and years of abundant moisture, stripping of rank growing cotton two months before a killing frost is beneficial rather than injurious.

This conclusion is contrary to the general opinion regarding cotton worm injury and the following question is therefore raised, What relation does the date of stripping bear to the amount of injury produced?

Scientific Notes

Predaceous Grasshoppers. We have had opportunity this summer to observe the highly predaceous feeding habits of one of the cricket-like grasshoppers, *Udeopsylla nigra* Scudder (determined by Professor Caudell). They were rather abundant at lights during the summer and were observed many times to be feeding on Lachnosterna adults. The beetles were either overpowered or directed into a corner and partly devoured. They generally gnawed off the legs of the beetles, leaving only stubs beyond the coxæ. In captivity they were fed May beetles and grasshoppers, upon which they readily fed. Sometimes a long and hard battle was necessary to overcome the larger grasshoppers. The writer knows of no reference to this species in literature as a predator of May beetles. R. C. Smith.

A Blossom Destroying Beetle on the Mango and Avocado. During the past spring avocado and mango groves in certain sections of southern Florida have been visited during the blossoming period by swarms of a small Scarabaeid beetle, *Anomala undulata* Mels. The beetle is nocturnal, carrying on its devastation at night, attacking the bloom spikes, cutting them off in many instances as with a knife. During the day the beetles seek shelter a short distance beneath the soil. Several groves noticed particularly were visited by swarms of this species and before any remedial and preventive measures could be carried out, considerable damage was accomplished by this pest. The habits of the larval stage are not known.

G. F. Moznette.

A Dipterous Parasite of the Parsnip Webworm (*Depressaria heracliana* Linn.). On July 12, 1920, there were received, for identification, larvæ of the parsnip webworm in wild parsnip from K. H. Fernow at Pleasant Valley, near Hammondsport, N. Y. Two of the caterpillars had pupated and these pupæ were placed in a vial for the purpose of rearing the moths. On July 18 a Tachinid fly emerged from one of the pupæ and was identified as *Dichaetoneura leucoptera* Johnson after having been compared with material from Maine in the Cornell University collection determined

by Johnson. A couple of dozen additional pupæ of the parsnip webworm were later received from Mr. Fernow, but no more parasites were obtained. The fly has apparently not before been recorded from this host and, so far as known, no other dipterous parasites have been reared from the parsnip webworm.

Dichaetoneura leucoptera was described as a new genus and species by C. W. Johnson (Psyche 14: 9, 1907), who received it from Winchendon, Mass., and Waterville, Me., where it was bred from the pupæ of *Archips cerasivorana* Fitch. Patch (Me. Agr. Exp. Sta. Bul. 149: 265, 1907) bred this fly from *A. cerasivorana* in large numbers from various localities in Maine and also from *A. fervidana*. Herrick (Cornell Agr. Exp. Sta. Bul. 311: 291, 1912) has also reared *D. leucoptera* from *A. cerasivorana*, in New York.

Dr. Bezzi, who has compared specimens of this species with type material of the European *Phytomyptera nidiventris* Rondani, declares the two to be distinct.

M. D. LEONARD,
Ithaca, N. Y.

Indiana Insects. It is the plan of the Department of Entomology of Purdue University and the Agricultural Experiment Station to build up a collection of insects which will satisfactorily represent the insects found in the Central West, east of the Mississippi, and particularly those of Indiana. Records, publications dealing with Indiana insects, and specimens themselves are solicited.

Careful records of occurrence and economic importance will be kept with a view to publishing the "Insects of Indiana" at a future date. Records should, therefore, include name, authority for determination, exact locality, date of capture, stage, host if known, collector and other pertinent data.

Your coöperation is earnestly solicited. JOHN J. DAVIS,
Agricultural Experiment Station, Lafayette, Indiana.

A New Apple Pest in Pennsylvania. A new pest, *Eulia velutinana* Walk, has become serious in southern Pennsylvania. The species is well known as a general feeder and has been recorded from Maple and Balsam. Heretofore it has not been recorded from apple. It was first noticed on apple in the spring of 1918, and has since been increasing in numbers and importance. This spring it was exceedingly numerous and attracted the attention of many who previously overlooked it.

An abundance of larvæ have been reared and the adults kindly determined by Mr. August Busck. In need of a common name the writer has been calling it the two-banded leaf roller. This distinguishes it from the four-banded leaf roller, *Eulia quadrifasciana* Fernald, which is a pest in New York State.

The species passes the winter as adults which issue about the middle of May and lay their eggs in masses on the larger limbs and trunks of the apple. The larvæ are yellowish-green and three-quarters of an inch long when full grown. They transform the latter part of June and the adults issue, laying their eggs in masses of twenty to forty on the leaves. The eggs are yellowish-brown in color and very much flattened, resembling the eggs of other leaf rollers. There is no doubt that there are several generations during the summer.

Considerable injury has been noticed on drop fruit caused by this species. The cavities are usually shallow although frequently they are deep and resemble those of the green fruit worm but smaller. During the summer they continue their depredations. In the late fall the species has been observed feeding on the fruit and making large shallow cavities. It is not uncommon to find the larvæ feeding at the time the fruit are picked. S. W. FROST.

State College Research Laboratories,
Arendtsville, Pa.

An Insect Supposed to Breed in Corn. During the past few months much interest has been shown in the European corn borer, *Pyrausta nubilalis*. Native insects affecting corn are also of interest. In view of this fact the writer wishes to call attention to an insect, which for years has been supposed to breed in corn. It is quite possible, as the writer will attempt to prove, that the describer of the insect was in error as to its host plant or he would not have given it the name of *Achatodes zeæ*.

In the latter half of May the writer collected several lepidopterous larvæ from the stems of elder. These larvæ resembled the true cornstalk borer, *Diatraea zeacollela*, so much, that the specimens were forwarded to Mr. August Busck for determination. Mr. Busck determined them as *Achatodes zeæ* stating that their host plants were strawberry and corn.

Later the writer asked Dr. F. H. Chittenden if he knew anything about the host plants of this insect. Dr. Chittenden wrote the writer a rather detailed account, which is given here verbatim: "Being interested in stalk borers that affect truck crops, I am able to give you valuable information in regard to *Achatodes zeæ* Harris.

"This is one of the cases in which Dr. Harris was wrong. This species which was described in Harris' Treatise feeds exclusively, so far as records go, in the stems of elder (*Sambucus* sp.) and any other records of its injuring corn and strawberry are, in my opinion, incorrect. The true corn and strawberry culprit is *Papaipema nitela* or *nebris;* in other words, the species mentioned by Harris in 'Insects Injurious to Vegetation,' Flint Edition, 1862, pp. 438–440, refers to both species. The moth figured on Plate 7, figure 9, is *Achatodes zeæ* and the larva figured on page 440 is *Papaipema nebris.*"

Larvæ of this species were fairly common in the stems of elder at Tullulah, La., during the last of May and the first of June.

Marion R. Smith.

A Note on Migration of Larvae of the House-Fly. Along a stretch of some 150 feet of road in Wellington, Kansas, there is found a strip of grass about two feet wide along one side of which a cement sidewalk runs and along the other a cement curb raised perhaps eight inches above the macadamized road with which it is connected. The whole is gently sloping to the west.

About the 15th of May, 1917, this grass area as well as a plot of some two acres adjoining the sidewalk was covered with a thick layer of barnyard manure which had probably been stacked for some time.

A few days later, about 6.00 o'clock in the morning, in passing by this stretch of road, large numbers of the larvae of the house-fly, *Musca domestica*, were observed on the sidewalk and in the gutter adjoining the manured strip. They were only fairly numerous on the sidewalk, but in the gutter they lay in a white band extending the whole length of the manured space, perhaps eight inches wide and towards the curb several larvae deep.

This whole seething mass was working down the street towards the west and were found to be entering a sewage manhole which adjoined the west end of the manured area.

By noon this date, practically all the larvae had disappeared.

Considering that the majority of the larvae had entered the manhole, they had migrated from one to 150 feet. And they had preferred migrating this distance in search of soil in which to pupate rather than enter the soil beneath the manure.

George W. Barber,
Scientific Assistant, Bureau of Entomology, U. S. Department of Agriculture.

JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

DECEMBER, 1920

The editors will thankfully receive news items and other matter likely to be of interest to subscribers. Papers will be published, so far as possible, in the order of reception. All extended contributions, at least, should be in the hands of the editor the first of the month preceding publication. Contributors are requested to supply electrotypes for the larger illustrations so far as possible. Photo-engravings may be obtained by authors at cost. The receipt of all papers will be acknowledged.—Eds.

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This is the official organ of the American Association of Economic Entomologists, an organization of 566 members, each with equal or nearly equal rights to the privileges and benefits of the organization. The volume for this year is practically filled with the Proceedings of the Annual Meeting and those of the Pacific Slope Branch and, as a consequence, there has been no space for the independently submitted papers. It is fitting that the Proceedings should be given precedence according to custom, because the doings of the annual gatherings are of general interest to the entire membership. It is highly desirable that the man unable to attend or the one with an important message should have an opportunity to present his case. The JOURNAL should cover a wider field than the publishing of the Proceedings and it is highly desirable that its pages be open to all qualified contributors. The high cost of printing and the limited funds available make it impossible to issue a larger volume and, while such conditions exist, it is suggested that those attending the meetings keep the matter in mind and by means of carefully prepared papers, abstracted if necessary, keep down the length of the articles and thus reduce the size of the Proceedings. The formal papers in the volumes for 1917–1919 inclusive have an average length of about six pages, 2,400 words. It may be necessary to keep papers pretty closely within these limits; that is, make the average of the past few years the approximate maximum of the present and thus give a more equal opportunity to our entire membership. The value of a paper should not be gauged by its length; it is the message that counts. There is no better time than the present to excel in the selection of the pertinent and thus assist in making room for the other man.

Reviews

Insect Artizans and Their Work. By EDWARD STEP. Pages 1 to 318. 54 illustrations. Dodd, Mead and Company, 1920.

We have in this little volume an interesting series of sympathetic discussions of the activities of various insects, their nature being indicated by such titles as spinners and weavers, miners, masons, carpenters and wood-workers, upholsterers, wax-workers, paper makers, tailors, etc. The author, following the lead of Fabre, has brought into a volume records of the habits of a number of the more interesting typical species, mostly European, some American and others from different parts of the world. Those with a liking for natural history and the adaptation of life to varying conditions, will find much that is suggestive and stimulating. We have in this volume, non-technical accounts, attractive to the amateur and by no means uninteresting to those who have penetrated deeper into the mysteries of nature.

Current Notes

Conducted by the Associate Editor

Mr. William Beutenmuller has changed his address to Box 258, Highwood, Bergen County, N. J.

The annual meeting of the New York State beekeepers took place at Syracuse, December 1–3.

Mr. F. G. Graham has been appointed temporary superintendent of fumigation at Windsor, Ontario.

Dr. C. C. Miller, a prominent authority on apiculture, died at his home, Marengo, Ill., September 4, 1920.

Mr. Harlan P. Worthley has been appointed investigator in entomology at the Massachusetts Agricultural College.

Mr. A. C. Mason, Bureau of Entomology, has been assigned to work on biological studies of rust mites at Orlando, Fla.

Mr. Arthur D. Borden, Bureau of Entomology, is now in charge of the laboratory at Alhambra, Calif., vice R. S. Woglum, resigned.

The *Experiment Station Record* announces the resignation of V. R. Haber, as research assistant in entomology at the Minnesota Station.

According to *Science*, Professor Harold R. Hagan has resigned as professor of zoölogy and entomology, at the Utah Agricultural College.

The North-Western Beekeepers' Association held its annual meeting at the Great Northern Hotel, Chicago, on Monday and Tuesday, December 6 and 7.

Professor W. W. Henderson, formerly entomologist at the Utah Station and College, has been appointed president of Brigham Young College, Logan, Utah.

The degree of doctor of laws has been conferred by Brown University upon Professor Vernon Kellogg of Stanford University, now secretary of the National Research Council.

Entomologists have just learned of the death of Mr. William H. Patton, of Hartford, Conn. Mr. Patton died a year or more ago. For many years he had been in the Retreat for the Insane at Hartford, and formerly published a number of articles

in the entomological journals, mostly dealing with the Hymenoptera, in which he described several new species.

Mr. Mitchell Carroll, assistant in entomology, New Jersey Agricultural Experiment Station, has resigned to accept a professorship at a college in Pennsylvania.

According to *Science,* Professor William J. Crozier of the University of Chicago has been appointed professor of zoölogy and public health at Rutgers College, New Brunswick, N. J.

Mr. Herbert J. Pack has been appointed instructor in zoölogy and assistant entomologist at the Utah College and Station, vice Charles J. Sorenson, resigned to engage in commercial work.

Mr. George S. Demuth, for several years connected with the Bureau of Entomology, Division of Apiculture, will soon relinquish government work to become editor-in-charge of *Gleanings in Bee Culture.*

According to *Experiment Station Record,* Professor C. E. Sanborn, entomologist of the Oklahoma College and Station, is to spend the coming year in California on special entomological investigations.

Mr. George B. Pearson, a graduate of the Mississippi Agricultural and Mechanical College, has been appointed field assistant in the Bureau of Entomology with headquarters at West Lafayette, Ind.

Mr. Arthur Gibson, dominion entomologist, Ottawa, Canada, spent a few days at Boston and vicinity in September, visiting the various laboratories maintained by the United States Bureau of Entomology.

Professor W. C. O'Kane has been elected president of the Faculty Science Club of the New Hampshire College. Professor O'Kane recently met with an accident in which he lost the end of one of his fingers.

According to *Science,* Professor T. D. A. Cockerell, of the University of Colorado, has been elected an honorary fellow of the American Museum of Natural History, in recognition of his distinguished services to science.

The fortieth annual convention of the Ontario Beekeepers' Association was held at the Agricultural College, Guelph, December 1–3. At this time will be formally opened the new apicultural building, which has been pronounced the finest one in North America.

Dr. Joseph L. Hancock, of Chicago, an authority on the grouse locusts (Tettiginæ) on account of increased medical responsibilities has given up his studies in the Orthoptera and his collection has been added to the Hebard collection at the Academy of Natural Sciences, Philadelphia.

Dr. T. J. Headlee spent two days in Connecticut, October 20 and 21, examining the equipment and methods of gipsy moth work. He gave a brief address before the Windham County Medical Association at Danielson, Conn., October 21, and also addressed the Connecticut Public Health Association at Hartford, Conn., November 11, both on the subject of mosquito elimination.

A hearing on extending the territory covered by the Japanese beetle quarantine was held before the Federal Horticultural Board in Washington, September 10, followed by a conference of entomologists concerning the recently discovered gipsy moth infestations in New Jersey and New York. According to the Florists' Exchange, the following entomologists were present: E. N. Corey, Maryland; L. A. Stearns, Virginia; E. C. Cotton, Ohio; C. R. Crosby, George G. Atwood, New York; T. J.

Headlee, John J. Davis, C. H. Hadley, H. B. Weiss, C. W. Stockwell, New Jersey; Dr. L. O. Howard, A. L. Quaintance, A. F. Burgess, C. L. Marlatt, W. R. Walton, E. R. Sasscer, E. H. Siegler, W. B. Wood, C. A. Weigel and H. W. Lamp, Bureau of Entomology, Washington, D. C.; E. D. Ball, assistant secretary of agriculture.

Larvæ of the satin moth *Stilpnotia salicis* Linn. were found in August, feeding upon poplars in New Westminster, B. C. This insect is a European species first reported on this continent from Medford, Mass., by Mr. A. F. Burgess, during the past summer. (See page 370 of this JOURNAL.)

Mr. Arthur Gibson, who for many years has been assistant entomologist in the Entomological Branch, Canadian Department of Agriculture, has been appointed dominion entomologist and head of the Entomological Branch to succeed the late Dr. C. Gordon Hewitt, who died in February, 1920.

Mr. W. E. Hinds, entomologist, Alabama Polytechnic Institute, lost his entire entomological library in the fire which destroyed the Agricultural Building October 17. He would appreciate the coöperation of fellow entomologists in replacing such bulletins and reports as may still be available for distribution.

According to the *Experiment Station Record*, a state appropriation of $5,000 has been made by the New York Legislature, at the request of fruit growers, for a special investigation by the State Station of the merits of the new dusting methods for the control of insect pests and fungous diseases as compared with spraying.

According to *Florists' Exchange*, Dr. E. D. Ball, assistant secretary of agriculture, and C. L. Marlatt, W. R. Walton, and L. H. Worthley of the Bureau of Entomology, left Washington October 2 to visit Massachusetts, New Hampshire, New York, Pennsylvania, and Ontario, to investigate damages by the European corn borer.

In New York State, a state employees' pension law has been enacted which affects all station workers. It provides for voluntary retirement at the age of 60, and compulsory retirement at 70 years. The amount of the pension is determined largely by the length of service and the salary at the time of retirement, but in no case can it exceed one-half the amount of the salary at the time of retirement.

Mr. J. L. King, entomological assistant of the Pennsylvania Bureau of Plant Industry, has been selected by Dr. A. L. Quaintance, who is in charge of the Japanese beetle investigations and control work, to study and collect parasites and predaceous enemies of the Japanese beetle in its native home. Mr. King sailed from San Francisco on October 20, and after a brief stop in Hawaii will proceed to join Mr. Claussen in Japan.

The following resignations from the Bureau of Entomology have been announced: Charles A. Bennett, Satsuma, Fla; Harold H. Link, Orlando, Fla; Ernest L. Chambers, Doylestown, Pa.; R. S. Woglum, Alhambra, Calif., to become director of entomology for the California Fruit Growers' Exchange; R. A. McKeown, Medford, Ore.; A. R. Moore, Riverton, N. J.; H. E. Thompson, Riverton, N. J.; H. E. Loomis, Macclenny, Fla.

Hessian fly "field laboratories" have been established in Ohio at Bryan, Sandusky, Columbus and Wooster by the Experiment Station, College of Agriculture and State Board of Agriculture. Entomologists of the three institutions are coöperating in a state-wide effort to minimize the damage to the wheat crop caused by this pest. C. H. Waid, of the Board of Agriculture, will have charge of the field work at Bryan; C. L. Metcalf, of the University, will be in charge at Columbus; P. R. Lowry is in charge at Sandusky, and H. A. Gossard is conducting the work at the Station. The

September *Monthly Bulletin* contains an article by T. H. Parks, entomologist of the University Extension Service, on "Wheat-Sowing Dates to Avoid Hessian Fly." Additional recommendations based on the present investigations will be widely disseminated by the county agents and press of the state.

Messrs. C. H. Curran, Vineland Station laboratory, I. J. Arnason, Lethbridge laboratory, V. C. Smith, F. P. Ide, headquarters, J. B. MacFarlane, R. S. Hawkins and Professor V. S. Pulling, spruce budworm survey, R. S. Longley, apple sucker quarantine, R. N. Bissonnette, field crop and garden insects and H. A. Robertson, Treesbank laboratory, have resigned from the Entomological Branch, Canadian Department of Agriculture.

Mr. Arthur Gibson, dominion entomologist, accompanied by Messrs. McLaine and Keenan, visited the European corn borer infestation in western New York on September 20, and were shown about by Mr. L. H. Worthley. On September 22, an important conference on the European corn borer was held at St. Thomas, Ont., at which Mr. W. R. Walton, L. H. Worthley Bureau of Entomology, and Dr. E. P. Felt, state entomologist of New York, were present.

After serving for twenty-five years as head of the Department of Horticulture and Entomology, and eleven years as head of the Department of Entomology of Purdue University and Experiment Station, Professor James Troop now relinquishes his position in the Experiment Station and will devote his time to teaching in the School of Agriculture. Professor John J. Davis, formerly with the United States Bureau of Entomology, is now head of the Department at Purdue.

According to *Science*, Professor George P. Gray, assistant professor of entomology, and chemist of the insecticide laboratory, University of California, has resigned to become chief of the division of chemistry of the newly organized California State Department of Agriculture, with headquarters at Sacramento. The work of the division of chemistry under Professor Gray includes the official analysis and testing of insecticides, fungicides, fertilizers, dairy products, and problems connected with the fruit and vegetable standardization laws.

AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

Important Notice.

Until January 1, 1921, orders for Banks Index to the Literature of American Economic Entomology, 1905 to 1914 inclusive, will be accepted for $5.00 per copy. The Colcord Index to the Literature of American Economic Entomology, 1915 to 1919 inclusive, $5.00 per copy. For delivery in foreign countries, 50¢ extra.

Payment should accompany order.

After January 1, 1921, orders for these books will be received at the following rates:

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Parties desiring to secure the lower rate must order before January 1.

A. F. Burgess, *Secretary*.

Melrose Highlands, Mass.
November 24, 1920.

Mailed December 22, 1920

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